# R&S®FS-K100/102/104PC
R&S®FSV-K100/102/104
R&S®FSQ-K100/102/104
EUTRA / LTE Downlink PC Software
User Manual

1308.9029.42 ─ 15

This manual covers the following products.

- R&S®FSQ-K100 (1308.9006.02)
- R&S®FSQ-K102 (1309.9000.02)
- R&S®FSQ-K104 (1309.9422.02)
- R&S®FSV-K100 (1310.9051.02)
- R&S®FSV-K102 (1310.9151.02)
- R&S®FSV-K104 (1309.9774.02)
- R&S®FS-K100PC (1309.9916.02)
- R&S®FS-K102PC (1309.9939.02)
- R&S®FS-K104PC (1309.9951.02)

The R&S®FS-K10xPC versions are available for the following spectrum and signal analyzers and oscilloscopes

- R&S®FSG
- R&S®FSQ
- R&S®FSV
- R&S®FSVR
- R&S®FSW
- R&S®RTO

The contents of the manual correspond to version 3.20 or higher.

The following abbreviations are used throughout this manual: R&S®FS-K100/-K102/-K104 is abbreviated as R&S FS-K100/-K102/-K104.

Customer Support

Technical support – where and when you need it

For quick, expert help with any Rohde & Schwarz equipment, contact one of our Customer Support Centers. A team of highly qualified engineers provides telephone support and will work with you to find a solution to your query on any aspect of the operation, programming or applications of Rohde & Schwarz equipment.

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North America	Phone 1-888-TEST-RSA (1-888-837-8772) customer.support@rsa.rohde-schwarz.com
Latin America	Phone +1-410-910-7988 customersupport.la@rohde-schwarz.com
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Contents

1 Introduction

Currently, UMTS networks worldwide are being upgraded to high speed downlink packet access (HSDPA) in order to increase data rate and capacity for downlink packet data. In the next step, high speed uplink packet access (HSUPA) will boost uplink performance in UMTS networks. While HSDPA was introduced as a 3GPP Release 5 feature, HSUPA is an important feature of 3GPP Release 6. The combination of HSDPA and HSUPA is often referred to as HSPA.

However, even with the introduction of HSPA, the evolution of UMTS has not reached its end. HSPA+ will bring significant enhancements in 3GPP Release 7. The objective is to enhance the performance of HSPA-based radio networks in terms of spectrum efficiency, peak data rate and latency, and to exploit the full potential of WCDMAbased 5 MHz operation. Important features of HSPA+ are downlink multiple input multiple output (MIMO), higher order modulation for uplink and downlink, improvements of layer 2 protocols, and continuous packet connectivity.

In order to ensure the competitiveness of UMTS for the next 10 years and beyond, concepts for UMTS long term evolution (LTE) have been investigated. The objective is a high-data-rate, low-latency and packet-optimized radio access technology. Therefore, a study item was launched in 3GPP Release 7 on evolved UMTS terrestrial radio access (EUTRA) and evolved UMTS terrestrial radio access network (EUTRAN). LTE/EUTRA will then form part of 3GPP Release 8 core specifications.

This introduction focuses on LTE/EUTRA technology. In the following, the terms LTE or EUTRA are used interchangeably.

In the context of the LTE study item, 3GPP work first focused on the definition of requirements, e.g. targets for data rate, capacity, spectrum efficiency, and latency. Also commercial aspects such as costs for installing and operating the network were considered. Based on these requirements, technical concepts for the air interface transmission schemes and protocols were studied. Notably, LTE uses new multiple access schemes on the air interface: orthogonal frequency division multiple access (OFDMA) in downlink and single carrier frequency division multiple access (SC-FDMA) in uplink. Furthermore, MIMO antenna schemes form an essential part of LTE. In an attempt to simplify protocol architecture, LTE brings some major changes to the existing UMTS protocol concepts. Impact on the overall network architecture including the core network is being investigated in the context of 3GPP system architecture evolution (SAE).

1.1 Requirements for UMTS Long-Term Evolution

LTE is focusing on optimum support of packet switched (PS) services. Main requirements for the design of an LTE system are documented in 3GPP TR 25.913 [1] and can be summarized as follows:

- Data Rate: Peak data rates target 100 Mbps (downlink) and 50 Mbps (uplink) for 20 MHz spectrum allocation, assuming two receive antennas and one transmit antenna are at the terminal.

- Throughput: The target for downlink average user throughput per MHz is three to four times better than Release 6. The target for uplink average user throughput per MHz is two to three times better than Release 6.

- Spectrum efficiency: The downlink target is three to four times better than Release 6. The uplink target is two to three times better than Release 6.

- Latency: The one-way transit time between a packet being available at the IP layer in either the UE or radio access network and the availability of this packet at IP layer in the radio access network/UE shall be less than 5 ms. Also C-plane latency shall be reduced, e.g. to allow fast transition times of less than 100 ms from camped state to active state.

- Bandwidth: Scaleable bandwidths of 5 MHz, 10 MHz, 15 MHz, and 20 MHz shall be supported. Also bandwidths smaller than 5 MHz shall be supported for more flexibility.

- Interworking: Interworking with existing UTRAN/GERAN systems and non-3GPP systems shall be ensured. Multimode terminals shall support handover to and from UTRAN and GERAN as well as inter-RAT measurements. Interruption time for hand-over between EUTRAN and UTRAN/GERAN shall be less than 300 ms for realtime services and less than 500 ms for non-realtime services.

- Multimedia broadcast multicast services (MBMS): MBMS shall be further enhanced and is then referred to as E-MBMS.

- Costs: Reduced CAPEX and OPEX including backhaul shall be achieved. Costeffective migration from Release 6 UTRA radio interface and architecture shall be possible. Reasonable system and terminal complexity, cost, and power consumption shall be ensured. All the interfaces specified shall be open for multivendor equipment interoperability.

- Mobility: The system should be optimized for low mobile speed (0 to 15 km/h), but higher mobile speeds shall be supported as well, including high speed train environment as a special case.

- Spectrum allocation: Operation in paired (frequency division duplex / FDD mode) and unpaired spectrum (time division duplex / TDD mode) is possible.

- Co-existence: Co-existence in the same geographical area and co-location with GERAN/UTRAN shall be ensured. Also, co-existence between operators in adjacent bands as well as cross-border co-existence is a requirement.

- Quality of Service: End-to-end quality of service (QoS) shall be supported. VoIP should be supported with at least as good radio and backhaul efficiency and latency as voice traffic over the UMTS circuit switched networks.

- Network synchronization: Time synchronization of different network sites shall not be mandated.

1.2 Long-Term Evolution Downlink Transmission Scheme

1.2.1 OFDMA

The downlink transmission scheme for EUTRA FDD and TDD modes is based on conventional OFDM.

In an OFDM system, the available spectrum is divided into multiple carriers, called subcarriers, which are orthogonal to each other. Each of these subcarriers is independently modulated by a low rate data stream.

OFDM is used as well in WLAN, WiMAX and broadcast technologies like DVB. OFDM has several benefits including its robustness against multipath fading and its efficient receiver architecture.

figure 1-1 shows a representation of an OFDM signal taken from 3GPP TR 25.892 [2]. In this figure, a signal with 5 MHz bandwidth is shown, but the principle is of course the same for the other EUTRA bandwidths. Data symbols are independently modulated and transmitted over a high number of closely spaced orthogonal subcarriers. In EUTRA, downlink modulation schemes QPSK, 16QAM, and 64QAM are available.

In the time domain, a guard interval may be added to each symbol to combat inter-OFDM-symbol-interference due to channel delay spread. In EUTRA, the guard interval is a cyclic prefix which is inserted prior to each OFDM symbol.
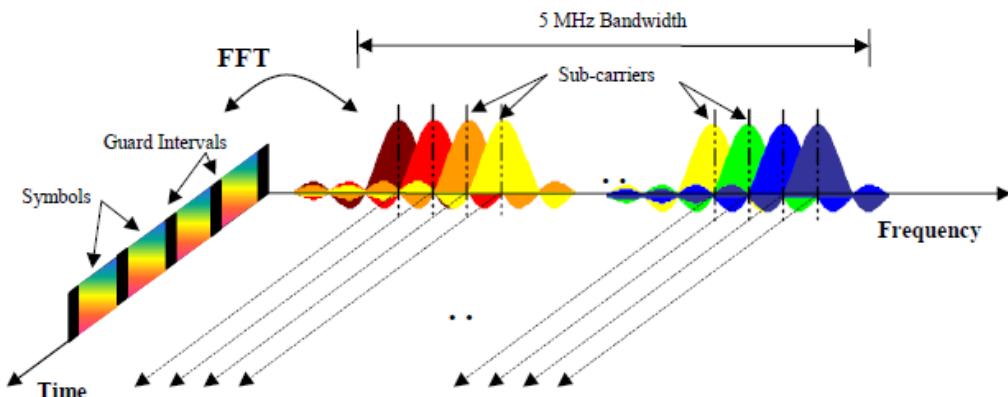
Fig. 1-1: Frequency-Time Representation of an OFDM Signal

In practice, the OFDM signal can be generated using the inverse fast Fourier transform (IFFT) digital signal processing. The IFFT converts a number N of complex data symbols used as frequency domain bins into the time domain signal. Such an N-point IFFT is illustrated in figure 1-2, where a(mN+n) refers to the nth subchannel modulated data symbol, during the time period $mT_u < t \leq (m+1)T_u$.
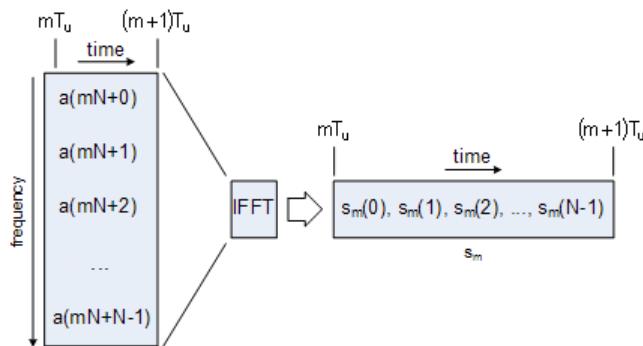
Fig. 1-2: OFDM useful symbol generation using an IFFT

The vector s_m is defined as the useful OFDM symbol. It is the time superposition of the N narrowband modulated subcarriers. Therefore, from a parallel stream of N sources of data, each one independently modulated, a waveform composed of N orthogonal sub-carriers is obtained, with each subcarrier having the shape of a frequency sinc function (see figure 1-1).

figure 1-3 illustrates the mapping from a serial stream of QAM symbols to N parallel streams, used as frequency domain bins for the IFFT. The N-point time domain blocks obtained from the IFFT are then serialized to create a time domain signal. Not shown in figure 1-3 is the process of cyclic prefix insertion.

Fig. 1-3: OFDM Signal Generation Chain

In contrast to an OFDM transmission scheme, OFDMA allows the access of multiple users on the available bandwidth. Each user is assigned a specific time-frequency resource. As a fundamental principle of EUTRA, the data channels are shared channels, i.e. for each transmission time interval of 1 ms, a new scheduling decision is taken regarding which users are assigned to which time/frequency resources during this trans-mission time interval.

1.2.2   OFDMA Parameterization

A generic frame structure is defined for both EUTRA FDD and TDD modes. Additionally, an alternative frame structure is defined for the TDD mode only. The EUTRA frame structures are defined in 3GPP TS 36.211. For the generic frame structure, the 10 ms radio frame is divided into 20 equally sized slots of 0.5 ms. A subframe consists of two consecutive slots, so one radio frame contains 10 subframes. This is illustrated in fig-ure 1-4 (T_s expresses the basic time unit corresponding to 30.72 MHz).
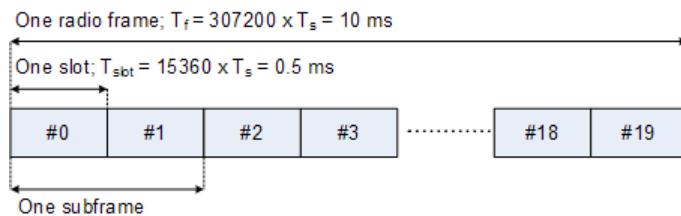
Fig. 1-4: Generic Frame Structure in EUTRA Downlink

figure 1-5shows the structure of the downlink resource grid for the duration of one down-link slot. The available downlink bandwidth consists of N_{BW}^{DL} subcarriers with a spacing of Δf = 15 kHz. In the case of multi-cell MBMS transmission, a subcarrier spacing of Δf = 7.5 kHz is also possible. N_{BW}^{DL} can vary in order to allow for scalable bandwidth operation up to 20 MHz. Initially, the bandwidths for LTE were explicitly defined within layer 1 spec-ifications. Later on a bandwidth agnostic layer 1 was introduced, with N_{BW}^{DL} for the different bandwidths to be specified by 3GPP RAN4 to meet performance requirements, e.g. for out-of-band emission requirements and regulatory emission limits.
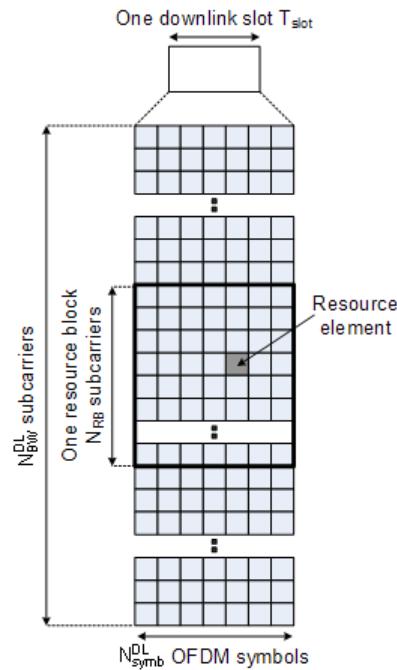
Fig. 1-5: Downlink Resource Grid

One downlink slot consists of N_{symb}^{DL} OFDM symbols. To each symbol, a cyclic prefix (CP) is appended as guard time, compare figure 1-1. N_{symb}^{DL} depends on the cyclic prefix length. The generic frame structure with normal cyclic prefix length contains N_{symb}^{DL} = 7 symbols. This translates into a cyclic prefix length of T_{CP}≈5.2µs for the first symbol and T_{CP}≈4.7µs for the remaining 6 symbols. Additionally, an extended cyclic prefix is defined in order to cover large cell scenarios with higher delay spread and MBMS transmission. The generic frame structure with extended cyclic prefix of T_{CP-E}≈16.7µs contains N_{symb}^{DL} = 6 OFDM sym-bols (subcarrier spacing 15 kHz). The generic frame structure with extended cyclic prefix

of $T_{CP-E} \approx 33.3\mu s$ contains N_{symb}^{DL} = 3 symbols (subcarrier spacing 7.5 kHz). table 1-1 gives an overview of the different parameters for the generic frame structure.

Table 1-1: Parameters for Downlink Generic Frame Structure

Configuration	Number of Symbols N_{symb}^{DL}	Cyclic Prefix Length in Samples	Cyclic Prefix Length in µs
Normal cyclic prefix Δf=15 kHz	7	160 for first symbol 144 for other symbols	5.2 µs for first symbol 4.7 µs for other symbols
Extended cyclic prefix Δf=15 kHz	6	512	16.7 µs
Extended cyclic prefix Δf=7.5 kHz	3	1024	33.3 µs

1.2.3 Downlink Data Transmission

Data is allocated to the UEs in terms of resource blocks. A physical resource block consists of 12 (24) consecutive subcarriers in the frequency domain for the Δf=15 kHz (Δf=7.5 kHz) case. In the time domain, a physical resource block consists of DL N_{symb} consecutive OFDM symbols, see figure 1-5. N_{symb}^{DL} is equal to the number of OFDM symbols in a slot. The resource block size is the same for all bandwidths, therefore the number of available physical resource blocks depends on the bandwidth. Depending on the required data rate, each UE can be assigned one or more resource blocks in each transmission time interval of 1 ms. The scheduling decision is done in the base station (eNodeB). The user data is carried on the physical downlink shared channel (PDSCH). Downlink control signaling on the physical downlink control channel (PDCCH) is used to convey the scheduling decisions to individual UEs. The PDCCH is located in the first OFDM symbols of a slot.

1.2.4 Downlink Reference Signal Structure and Cell Search

The downlink reference signal structure is important for cell search, channel estimation and neighbor cell monitoring. figure 1-6 shows the principle of the downlink reference signal structure for one-antenna, two-antenna, and four-antenna transmission. Specific predefined resource elements in the time-frequency domain carry the reference signal sequence. Besides first reference symbols, there may be a need for second reference symbols. The different colors in figure 1-6 represent the sequences transmitted from up to four transmit antennas.
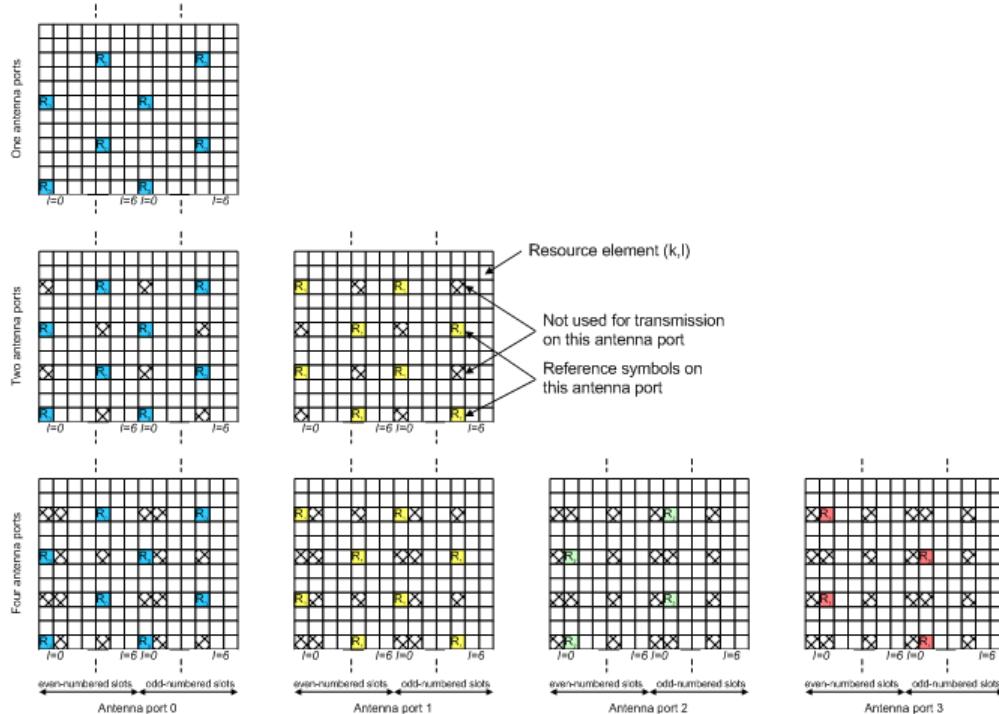
Fig. 1-6: Downlink Reference Signal Structure (Normal Cyclic Prefix)

The reference signal sequence carries the cell identity. Each reference signal sequence is generated as a symbol-by-symbol product of an orthogonal sequence r^{OS} (three of them existing) and a pseudo-random sequence r^{PRS} (170 of them existing). Each cell identity corresponds to a unique combination of one orthogonal sequence r^{OS} and one pseudo-random sequence r^{PRS}, allowing 510 different cell identities.

Frequency hopping can be applied to the downlink reference signals. The frequency hopping pattern has a period of one frame (10 ms).

During cell search, different types of information need to be identified by the handset: symbol and radio frame timing, frequency, cell identification, overall transmission bandwidth, antenna configuration, and cyclic prefix length.

Besides the reference symbols, synchronization signals are therefore needed during cell search. EUTRA uses a hierarchical cell search scheme similar to WCDMA. This means that the synchronization acquisition and the cell group identifier are obtained from different synchronization signals. Thus, a primary synchronization signal (P-SYNC) and a secondary synchronization signal (S-SYNC) are assigned a predefined structure. They are transmitted on the 72 center subcarriers (around the DC subcarrier) within the same predefined slots (twice per 10 ms) on different resource elements, see figure 1-7.
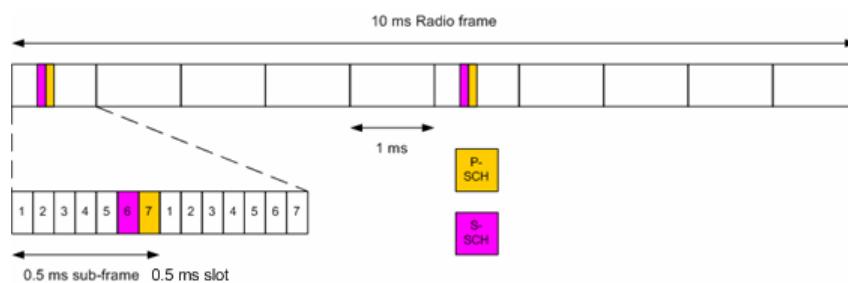
Fig. 1-7: P-SYNC and S-SYNC Structure

As additional help during cell search, a common control physical channel (CCPCH) is available which carries BCH type of information, e.g. system bandwidth. It is transmitted at predefined time instants on the 72 subcarriers centered around the DC subcarrier.

In order to enable the UE to support this cell search concept, it was agreed to have a minimum UE bandwidth reception capability of 20 MHz.

1.2.5 Downlink Physical Layer Procedures

For EUTRA, the following downlink physical layer procedures are especially important:

- **Cell search and synchronization**
  See above.

- **Scheduling**
  Scheduling is done in the base station (eNodeB). The downlink control channel PDCCH informs the users about their allocated time/frequency resources and the transmission formats to use. The scheduler evaluates different types of information, e.g. quality of service parameters, measurements from the UE, UE capabilities, and buffer status.

- **Link adaptation**
  Link adaptation is already known from HSDPA as adaptive modulation and coding. Also in EUTRA, modulation and coding for the shared data channel is not fixed, but rather is adapted according to radio link quality. For this purpose, the UE regularly reports channel quality indications (CQI) to the eNodeB.

- **Hybrid automatic repeat request (ARQ)**
  Downlink hybrid ARQ is also known from HSDPA. It is a retransmission protocol. The UE can request retransmissions of incorrectly received data packets.

1.3 References

[1] 3GPP TS 25.913: Requirements for E-UTRA and E-UTRAN (Release 7)

[2] 3GPP TR 25.892: Feasibility Study for Orthogonal Frequency Division Multiplexing (OFDM) for UTRAN enhancement (Release 6)

[3] 3GPP TS 36.211 v8.3.0: Physical Channels and Modulation (Release 8)

[4] 3GPP TS 36.300: E-UTRA and E-UTRAN; Overall Description; Stage 2 (Release 8)

[5] 3GPP TS 22.978: All-IP Network (AIPN) feasibility study (Release 7)

[6] 3GPP TS 25.213: Spreading and modulation (FDD)

[7] Speth, M., Fechtel, S., Fock, G., and Meyr, H.: Optimum Receiver Design for Wireless Broad-Band Systems Using OFDM – Part I. IEEE Trans. on Commun. Vol. 47 (1999) No. 11, pp. 1668-1677.

[8] Speth, M., Fechtel, S., Fock, G., and Meyr, H.: Optimum Receiver Design for OFDM-Based Broadband Transmission – Part II: A Case Study. IEEE Trans. on Commun. Vol. 49 (2001) No. 4, pp. 571-578.

2   Welcome

The EUTRA/LTE measurement software makes use of the I/Q capture functionality of the following spectrum and signal analyzers to enable EUTRA/LTE TX measurements conforming to the EUTRA specification.

● R&S FSQ

● R&S FSG

● R&S FSV

● R&S FSVR

● R&S FSW

● R&S RTO

This manual contains all information necessary to configure, perform and analyze such measurements.

2.1   Licensing the Software

The software provides the following general functionality.

● To capture and analyze I/Q data from an R&S®FSW, R&S®FSV, R&S®FSVR, R&S®FSQ, R&S®FSG or R&S®RTO.

● To read and analyze I/Q data from a file.

License type

You can purchase two different license types for the software.

● R&S®FS-K10xPC
This license supports software operation with and without an R&S instrument (analyzer or oscilloscope).
The software works with a connection to an analyzer but also supports the analysis of data stored in a file. This license type requires a smartcard reader (dongle).

● R&S®FSV/FSQ-K10x
This license requires a connection to an R&S®FSV, R&S®FSVR, R&S®FSQ or R&S®FSG. The license must be installed on the analyzer.

Using the smartcard reader (dongle)

Before you can use the software, you have to load the license(s) on a smartcard (if you already have one) or order a new smartcard (R&S FSPC). New license types are available as registered licenses (see below).

You can use the smart card together with the USB smart card reader (for SIM format) supplied with the software. Alternatively, you can insert the smart card (full format) in a reader that is connected to or built into your PC.

Note that support for problems with the smart card licensing can only be guaranteed if the supplied USB smart card reader (for SIM format) is used.

1. With the delivery of the R&S FSPC you got a smart card and a smart card reader.

2. Remove the smart card.

3. Insert the smart card into the reader.
   If the OMNIKEY label faces upward, the smart card has to be inserted with the chip facedown and the angled corner facing away from the reader.

4. After pushing the smart card completely inside the USB smart card reader, you can use it together with the software.

When you insert the USB Smartcard reader into the PC, the drivers will be loaded. If your PC does not already have drivers installed for this reader, the hardware will not be detected and the software will not work.

In this case, install the required driver manually. On the CD, it is in the folder `\Install\USB SmartCard Reader Driver Files`, named according to the pro-

cessor architecture (OMNIKEY3x21_x86... or OMNIKEY3x21_x64). Detailed information on the file content and the download location for updated drivers can be found in the `ReadMe.txt` file in the same folder.

ⓘ You may have problems locking a computer while the card is inserted, because MS Windows tries to get log-in information from the card immediately after you have locked the computer.

Solve this issue by changing a registry entry.

Either execute the registry file DisableCAD.reg in the same folder the USM Smartcard reader installation files are located. Or manually change the entry.

- Open the Windows Start Menu and select the "Run" item.
- Enter "regedit" in the dialog to open the system reigistry.
- Navigate to
  `HKEY_LOCAL_MACHINE\SOFTWARE\Microsoft\Windows\CurrentVersion\policies\system`.
- Set the value of DisableCAD to 0.

Note that security policies may prevent you from editing the value. Contact your IT administrator if you have problems with editing the value or installing the drivers.

Ordering licenses

In case of registered licenses, the license key code is based on the serial number of the R&S FSPC smartcard. Thus, you need to know the serial number when you order a new license.

1. Start the software (without a connected dongle).

2. Press the SETUP key.

3. Press the "Dongle License Info" softkey.

   The software opens the "Rohde & Schwarz License Information" dialog box.
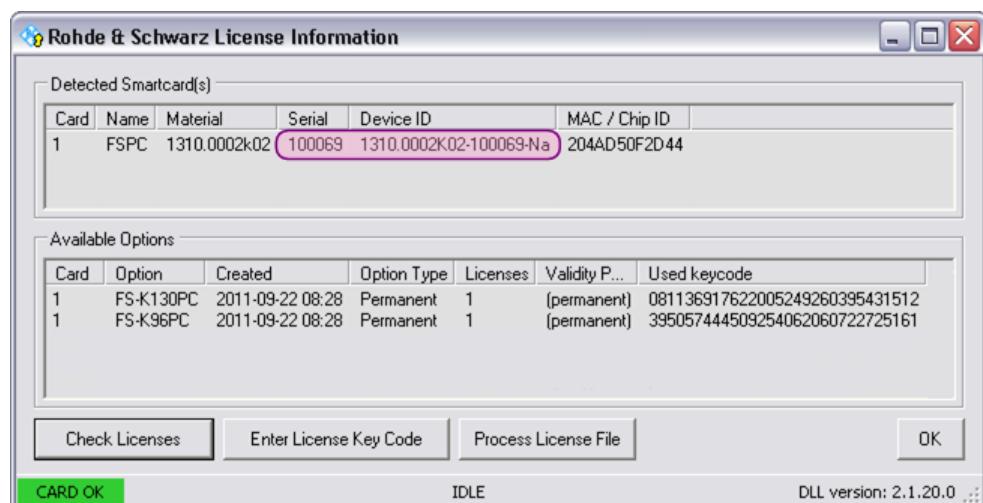
4. Connect the smartcard / dongle to the computer.

5. Press the "Check Licenses" button.

   The software shows all current licenses.
   The serial number which is necessary to know if you need a license is shown in the "Serial" column.
   The "Device ID" also contains the serial number.

6. To enter a new license code, press the "Enter License Key Code" button.

2.2 Installing the Software

For information on the installation procedure see the release notes of the software.

2.3 Connecting the Computer to an Analyzer

In order to be able to communicate with an analyzer (R&S FSQ, R&S FSG, R&S FSV, R&S FSVR or R&S FSW) or oscilloscope (R&S RTO family), you have to connect it to a computer. You can use the IEEE bus (GPIB) or a local area network (LAN).

Requirements

To be able to capture I/Q data, you need one of the signal analyzers or oscilloscopes mentioned above.

If you are using an R&S FSQ, you must

● use firmware 3.65 or higher to be able to establish a connection via TCP/IP
   or

● install the RSIB passport driver on the computer.
   The driver is available for download at http://www.rohde-schwarz.com/appnote/1EF47

To establish a connection, you also have to determine the network address of the analyzer and set it up in the LTE software.

2.3.1 Instrument Configuration

The functionality necessary to establish the connection to the test equipment is part of the "Analyzer Config / MIMO Setup" tab of the "General Settings" dialog box.

The software supports simultaneous connections to several analyzers or oscilloscopes. Using a combination of analyzers and oscilloscopes is also possible. The software automatically detects if you have connected an analyzer or an oscilloscope. On the whole, you can perform measurement on up to eight input channels. Each input channel captures one I/Q data stream.

If you use a spectrum or signal analyzer, one input channel corresponds to one instrument's RF input. Thus, the required number of analyzers depends on the number of I/Q

data streams you want to measure. The analyzers have to be connected to each other with one analyzer controlling the other instruments by providing the trigger.

If you use an oscilloscope, the number of required instruments depends on the number of channels available on the oscilloscope.

2.3.1.1 General Instrument Configuration

The general analyzer or oscilloscope configuration determines the general MIMO setup. The purpose of the general MIMO setup is to assign an analyzer or oscilloscope channel to a particular I/Q data stream.

For successful measurements, you have to configure each instrument individually in the "Analyzer Configuration" table.

The number of table rows depends on the number of input channels you have selected.

Input Channel	VISA RSC	Number of Channels	Analyzer Input Channel
1 (Master)	LOCALHOST	3	1
2			2
3			3
4		1	1

Input Channel

Shows the number of the analyzer in the test setup or the channel number of an oscilloscope.

If you are using several instruments, the first input channel always represents the controlling (master) instrument.

VISA RSC

Opens a dialog box to configure the instrument connection in the network (see chapter 2.3.1.2, "Instrument Connection Configuration", on page 21.

If you perform MIMO measurements with several instruments, you have to establish a network connection for each instrument.

Number of Channels

Defines the number of channels of an oscilloscope that you want to use.

The number of instruments to configure is reduced if you use an instrument with more than one channel. The software also adjusts the contents of the "Analyzer Input Channel".

If you perform the measurement with one or more signal analyzers (for example R&S FSW), the number of channels has to be "1".

SCPI command:

`CONFigure:ACONfig<analyzer>:NCHannels` on page 172

Analyzer Input Channel

Assigns one of the I/Q data streams (input channel) to a particular oscilloscope channel.

The "Analyzer Input Channel" has no effect if you use only instruments that have a single input channel.

SCPI command:

`CONFigure:ACONfig<analyzer>:ICSequence` on page 172

2.3.1.2 Instrument Connection Configuration

The "Instrument Connection Configuration" dialog box contains functionality that is necessary to successfully establish a connection in a network of analyzers. The dialog box contains several elements.
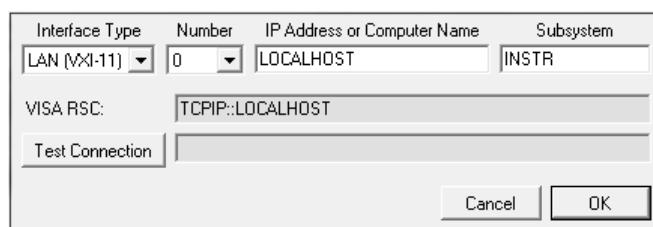
Interface Type

Selects the type of interface you want to use. You have to connect the analyzer or oscilloscope via LAN interface or the IEEE bus (GPIB).

Number

Selects the number of the interface if the PC has more than one interfaces (e.g. several LAN cards).

Address

Defines the address of the instrument. The type of content depends on the interface type.

● GPIB Address
Primary GPIB address of the analyzer. Possible values are in the range from 0 to 31.
The default GPIB address for an R&S instruments is 20.
Available for IEEE bus systems using the IEEE 488 protocol. The interface type is GPIB.

● IP Address or Computer Name
Name or host address (TCP/IP) of the computer.
Available for LAN bus systems using either the VXI-11 protocol or a Rohde&Schwarz specific protocol (RSIB). The interface type is either LAN (VXI-11) or LAN (RSIB).
Contact your local IT support for information on free IP addresses.
– The RSIB protocol is supported by all firmware version of the R&S analyzers and oscilloscopes.

– The VXI-11 protocol is supported as of R&S FSQ firmware version 3.65 and by all firmware version of the R&S FSV(R), R&S FSG and oscilloscopes.

● Complete VISA Resource String
Allows you to enter the complete VISA resource string manually. A VISA string is made up out of the elements mentioned above, separated by double colons (::), e.g. `GPIB::20::INSTR`.
Available for interface type "Free Entry".

Subsystem

Shows the subsystem in use. Typically you do not have to change the subsystem.

VISA RSC

Shows or defines the complete VISA resource string.

SCPI command:

`CONFigure:ACONfig<analyzer>:ADDRess` on page 171

Test Connection

Button that tests the connection.

If the connection has been established successfully, the software returns a PASSED message. If not, it shows a FAILED message.

2.3.2   Figuring Out IP Addresses

Each of the supported instruments logs its network connection information in a different place. Find instructions on how to find out the necessary information below.

2.3.2.1   Figuring Out the Address of an R&S FSQ or R&S FSG

Follow these steps to figure out GPIB or IP address of an R&S FSQ or R&S FSG.

Figuring Out the GPIB address

1. Press the SETUP key.

2. Press the "General Setup" softkey.

3. Press the "GPIB" softkey.

   The R&S FSQ / FSG opens a dialog box that shows its current GPIB address.

Figuring Out the IP address

1. Press the SETUP key.

2. Press the "General Setup" softkey.

3. Press the "Configure Network" softkey.

4. Press the "Configure Network" softkey.

    The MS Windows "Network Connections" dialog box opens.

5. Select the "Local Area Connection" item.

    The "Local Area Connection Status" dialog box opens.

6. Select the "Support" tab.

    The "Support" tab shows the current TCP/IP information of the R&S FSQ.
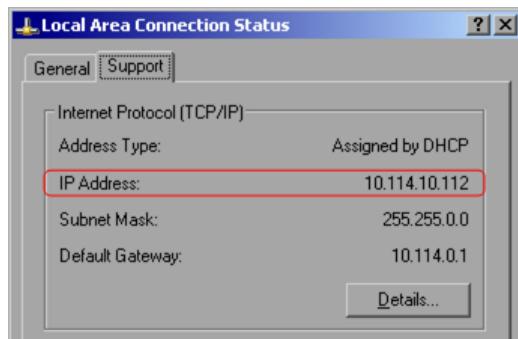
2.3.2.2 Figuring Out the Address of an R&S FSV or R&S FSVR

Follow these steps to figure out the GPIB or IP address of an R&S FSV or R&S FSVR.

Figuring Out the GPIB address

1. Press the SETUP key.

2. Press the "General Setup" softkey.

3. Press the "GPIB" softkey.

4. Press the "GPIB Address" softkey.

    The R&S FSV(R) opens a dialog box that shows its current GPIB address.

Figuring Out the IP address

1. Press the SETUP key.

2. Press the "General Setup" softkey.

3. Press the "Network Address" softkey.

4. Press the "IP Address" softkey.

    The R&S FSV(R) opens a dialog box that contains information about the LAN connection.
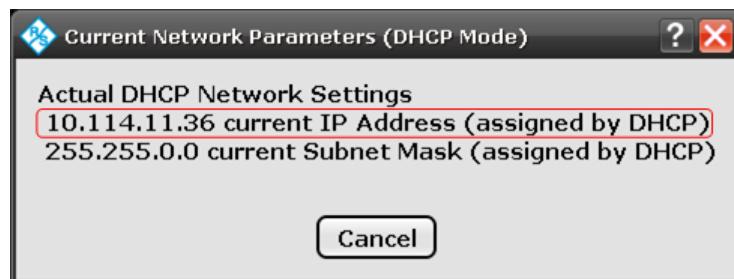
2.3.2.3 Figuring Out the Address of an R&S FSW

Follow these steps to figure out the GPIB or IP address of an R&S FSW.

Figuring Out the GPIB address

1. Press the SETUP key.

2. Press the "Network + Remote" softkey.

   The R&S FSW opens the "Network & Remote" dialog box.

3. Select the "GPIB" tab.

   The R&S FSW shows information about the GPIB connection, including the GPIB address.
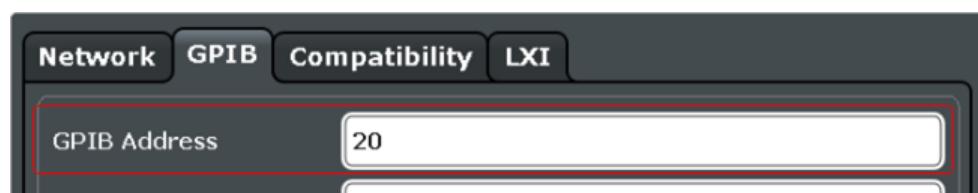
Figuring Out the IP address

1. Press the SETUP key.

2. Press the "Network + Remote" softkey.

   The R&S FSW opens the "Network & Remote" dialog box and shows its current IP address in the corresponding field.
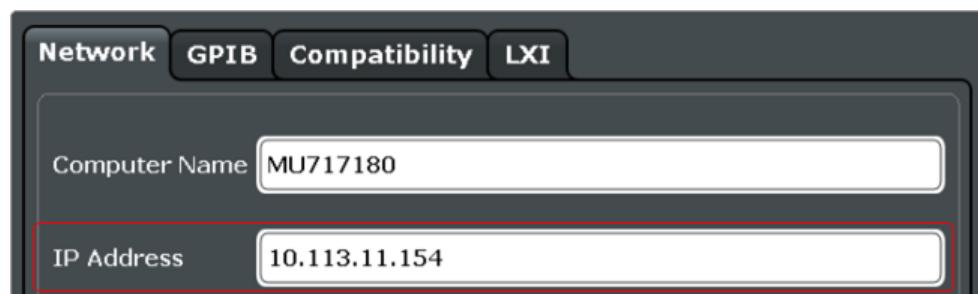
2.3.2.4   Figuring Out the Address of an R&S RTO

Follow these steps to figure out the network address of an R&S RTO.

► Press the SETUP key.

  The R&S RTO opens a dialog box that contains general information about the system.
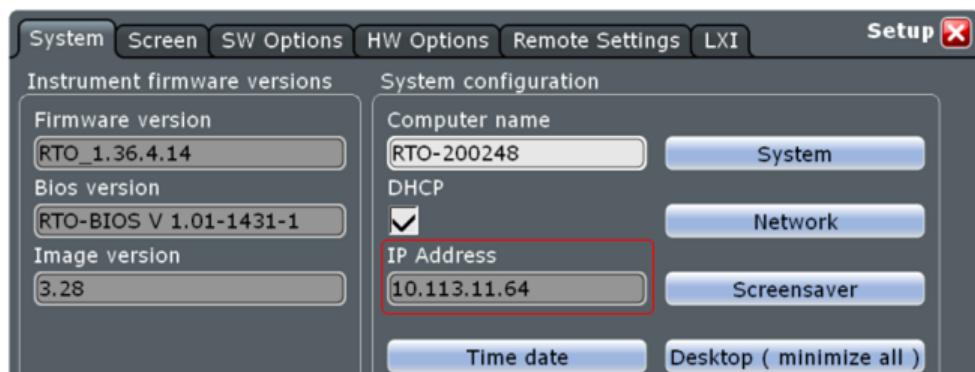
2.4 Application Overview

Starting the application

To start the software, use either the shortcut on the computer desktop or the entry in the Microsoft Windows Start menu.

If you run the software on an analyzer, access the software via the "Mode" menu.

► Press the MODE key and select "EUTRA/LTE".

Presetting the software

When you first start the software, all settings are in their default state. After you have changed any parameter, you can restore the default state with the PRESET key.

Note that using the preset function also presets an analyzer if one is connected and you capture the data from the hardware.

CONFigure:PRESet on page 201

Using the preset if the software has been installed on an R&S FSQ, R&S FSG, R&S FSV, R&S FSVR or R&S FSW presets the software and the analyzer and exits the LTE software.

SCPI command:

`*RST`

Elements and layout of the user interface

The user interface of the LTE measurement application is made up of several elements.

1 = Header table. The header table shows basic information like measurement frequency or sync state.
2 = Diagram area. The diagram area contains the measurement results. You can display it in full screen or split screen mode. The result display is separated in a header that shows the title etc. and the diagram area that show the actual results.
3 = Status bar. The status bar contains information about the current status of the measurement and the software.
4 = Hotkeys. Hotkeys contain functionality to control the measurement process.
5 = Softkeys. Softkeys contain functionality to configure and select measurement functions.
6 = Hardkeys. Hardkeys open new softkey menus.

The status bar

The status bar is located at the bottom of the display. It shows the current measurement status and its progress in a running measurement. The status bar also shows warning and error messages. Error messages are generally highlighted.

Display of measurement settings

The header table above the result displays shows information on hardware and measurement settings.

The header table includes the following information

- **Freq**
  The analyzer RF frequency.
- **Mode**
  Link direction, duplexing, cyclic prefix and maximum number of physical resource blocks (PRBs) / signal bandwidth.
- **CP/Cell Grp/ID**
  Shows the cell identity information.
- **Sync State**
  The following synchronization states may occur:
  - **OK** The synchronization was successful.
  - **FAIL (C)** The cyclic prefix correlation failed.
  - **FAIL (P)** The P-SYNC correlation failed.
  - **FAIL (S)** The S-SYNC correlation failed.

  Any combination of C, P and S may occur.
  SCPI Command:
  [SENSe]:SYNC[:STATe]? on page 132
- **Master Ref Level**
  Shows the reference level of the master analyzer.
- **Capture Time/Frame**
  Shows the capture length in ms.

2.5 Configuring the Software

This chapter contains information about general software functionality.

2.5.1 Configuring the Display

The "Display" menu contains functionality to improve the display and documentation of results.

► Press the DISP key.

The application features four screens (or result displays). Each of the screens may contain a different result display. The number of visible screens depends on the screen layout.

Full screen mode

In full screen mode, the application shows the contents a single screen.

► Press the "Full Screen" softkey.

If you have configured more than one result displays, these are still working in the background.

Split screen mode

In split screen mode, the application shows the contents of two screens, either screen A and screen B or screen C and screen D.

► Press the "Split Screen" softkey.

If you have configured more than two result displays, these are still working in the background.

2x2 split screen mode

In 2x2 split screen mode, the application shows the contents of four screens.

► Press the "2x2 Split Screen" softkey.

Limitations

For the Spectrum Emission Mask, ACLR and On/Off Power measurements, a maximum of two screens is possible.

By default, the software shows the results in all four screens. The screens are labeled A to D to the right of the measurement diagrams. The label of the currently active screen is highlighted green (A). The currently active screen is the one settings are applied to.

Switch between the screens with the "Screen A", "Screen B", "Screen C" and "Screen D" hotkeys.

The background color of the software by default is black. Apply another color via the "Color Selection" softkey and the corresponding dialog box.

For documentation purposes the software provides a hardcopy function that lets you save the current results in one of the following formats.

● bmp
● gif
● jpeg
● png
● tiff

Use the "Hardcopy to Clipboard" function to take a screenshot.

2.5.2 Configuring the Software

The "Setup" menu contains various general software functions.

► Press the SETUP key to access the "Setup" menu.

Configure Analyzer Connection
Opens the "General Settings" dialog box.

For more information see "MIMO Analyzer Configuration" on page 73.

Data Source (Instr File)
Selects the general input source (an instrument or a file).

For more information see "Selecting the Input Source" on page 63.

Dongle License Info
Opens the "Rohde & Schwarz License Information" dialog box.

The dialog box contains functionality to add new (registered) licenses. For more information see chapter 2.1, "Licensing the Software", on page 16.

"Check Licenses"	Looks for all smartcards connected to the computer and returns their characteristics like the serial number of the smartcard or its device ID. Note that the smartcard has to be connected to figure out its properties.
"Enter License Key Code"	Opens an input field to manually enter a new license key code. A key code consists of 30 digits.
"Process License File"	Opens a dialog box to select a file (xml format) that contains a license. Opening that file automatically adds a new license.

Show Logging
Opens a dialog box that contains a log of all messages that the software has shown in the status bar.

Use the message log for debugging purposes in case any errors occur. You can refresh and clear the contents of the log or copy the contents of the system log to the clipboard.

"Refresh"	Updates the contents of the log.
"Clear All"	Deletes all entries in the log.
"Copy to Clipboard"	Copies the contents of the log to the clipboard.

System Info
Opens a dialog box that contains information about the system like driver versions or the utility software. You can use this information in case an analyzer does not work properly.

3 Measurements and Result Displays

The LTE measurement software features several measurements to examine and analyze different aspects of an LTE signal.

The source of the data that is processed is either a live signal or a previously recorded signal whose characteristics have been saved to a file. For more information see "Selecting the Input Source" on page 63.

In both cases, you can perform a continuous or a single measurement.

Continuous measurements capture and analyze the signal continuously and stop only after you turn it off manually.

► Press the "Run Cont" softkey to start and stop continuous measurements.

Single measurements capture and analyze the signal over a particular time span or number of frames. The measurement stops after the time has passed or the frames have been captured.

► Press the "Run Sgl" softkey to start a single measurement.

You can also repeat a measurement based on the data that has already been captured, e.g. if you want to apply different demodulation settings to the same signal.

► Press the "Refresh" softkey to measure the signal again.

This chapter provides information on all types of measurements that the LTE measurement software supports.

Note that all measurements are based on the I/Q data that is captured except the Spectrum Emission Mask and the Adjacent Channel Leakage Ratio. Those are based on a frequency sweep the analyzer performs for the measurement.

SCPI command:

`INITiate[:IMMediate]` on page 131

`INITiate:REFResh` on page 131

3.1 Numerical Results

Result Summary

The Result Summary shows all relevant measurement results in numerical form, combined in one table.

▸ Press the "Display (List Graph)" softkey so that the "List" element turns green to view the Result Summary.

SCPI command:

`DISPlay[:WINDow<n>]:TABLe` on page 131

Contents of the result summary

Result Summary	Selection	Antenna: 1				
Frame Results 1/1	Min	Mean	Mean Limit	Max	Max Limit	Unit
EVM PDSCH QPSK	123,97	123,97		123,97	18,50	%
EVM PDSCH 16QAM	112,83	112,83		112,83	13,50	%
EVM PDSCH 64QAM	105,67	105,67		105,67	9,00	%
Results for Selection	Subframes ALL				Frame 1/1	
EVM All	104,65	109,30		111,83		%
EVM Phys. Channel	104,65	109,30		111,83		%
EVM Phys. Signal						%
Frequency Error	-12341,93	-5079,97		3893,56		Hz
Sampling Error	-1429,59	649,15		3092,63		ppm
IQ Offset	-197,27	-184,30		-177,51		dB
IQ Gain Imbalance	-0,23	0,05		0,40		dB
IQ Quadrature Error	-2,28	-0,82		0,99		°
RSTP	-23,99	-23,39		-22,90		dBm
OSTP	4,11	4,11		4,11		dBm
RSSI	4,11	4,11		4,11		dBm
Power	4,11	4,11		4,11		dBm
Crest Factor		7,74				dB

The table is split in two parts. The first part shows results that refer to the complete frame. For each result, the minimum, mean and maximum values are displayed. It also indicates limit check results where available. The font of 'Pass' results is green and that of 'Fail' results is red.

By default, the software checks the limits defined by the standard. You can also import customized limits. In that case the software evaluates those limits instead of the predefined ones. For more information see chapter 7.3, "Importing and Exporting Limits", on page 110.

EVM PDSCH QPSK	Shows the EVM for all QPSK-modulated resource elements of the PDSCH channel in the analyzed frame.
	`FETCh:SUMMary:EVM:DSQP[:AVERage]?` on page 135
EVM PDSCH 16QAM	Shows the EVM for all 16QAM-modulated resource elements of the PDSCH channel in the analyzed frame.
	`FETCh:SUMMary:EVM:DSST[:AVERage]?` on page 135
EVM PDSCH 64QAM	Shows the EVM for all 64QAM-modulated resource elements of the PDSCH channel in the analyzed frame.
	`FETCh:SUMMary:EVM:DSSF[:AVERage]?` on page 135

By default, all EVM results are in %. To view the EVM results in dB, change the EVM Unit.

The second part of the table shows results that refer to a specifc selection of the frame.

The statistic is always evaluated over the subframes.

The header row of the table contains information about the selection you have made (like the subframe).

EVM All	Shows the EVM for all resource elements in the analyzed frame.
	`FETCh:SUMMary:EVM[:ALL][:AVERage]?` on page 134
EVM Phys Channel	Shows the EVM for all physical channel resource elements in the analyzed frame.
	A physical channel corresponds to a set of resource elements carrying information from higher layers. PDSCH, PBCH or PDCCH, for example, are physical channels. For more information see 3GPP 36.211.
	`FETCh:SUMMary:EVM:PCHannel[:AVERage]?` on page 136
EVM Phys Signal	Shows the EVM for all physical signal resource elements in the analyzed frame.
	The reference signal, for example, is a physical signal. For more information see 3GPP 36.211.
	`FETCh:SUMMary:EVM:PSIGnal[:AVERage]?` on page 136
Frequency Error	Shows the difference in the measured center frequency and the reference center frequency.
	`FETCh:SUMMary:FERRor[:AVERage]?` on page 136
Sampling Error	Shows the difference in measured symbol clock and reference symbol clock relative to the system sampling rate.
	`FETCh:SUMMary:SERRor[:AVERage]?` on page 139
I/Q Offset	Shows the power at spectral line 0 normalized to the total transmitted power.
	`FETCh:SUMMary:IQOFfset[:AVERage]?` on page 137
I/Q Gain Imbalance	Shows the logarithm of the gain ratio of the Q-channel to the I-channel.
	`FETCh:SUMMary:GIMBalance[:AVERage]?` on page 137
I/Q Quadrature Error	Shows the measure of the phase angle between Q-channel and I-channel deviating from the ideal 90 degrees.
	`FETCh:SUMMary:QUADerror[:AVERage]?` on page 138

RSTP	Shows the reference signal transmit power as defined in 3GPP TS 36.141. It is required for the "DL RS Power" test.
	It is an average power and accumulates the powers of the reference symbols within a subframe divided by the number of reference symbols within a subframe.
	`FETCh:SUMMary:RSTP[:AVERage]?` on page 139
OSTP	Shows the OFDM symbol transmit power as defined in 3GPP TS 36.141.
	It accumulates all subcarrier powers of the 4th OFDM symbol. The 4th (out of 14 OFDM symbols within a subframe (in case of frame type 1, normal CP length)) contains exclusively PDSCH.
	`FETCh:SUMMary:OSTP[:AVERage]?` on page 137
RSSI	Shows the Received Signal Strength Indicator. The RSSI is the complete signal power of the channel that has been measured, regardless of the origin of the signal.
	`FETCh:SUMMary:RSSI[:AVERage]?` on page 139
Power	Shows the average time domain power of the analyzed signal.
	`FETCh:SUMMary:POWer[:AVERage]?` on page 138
Crest Factor	Shows the peak-to-average power ratio of captured signal.
	`FETCh:SUMMary:CRESt[:AVERage]?` on page 134

3.2 Measuring the Power Over Time

This chapter contains information on all measurements that show the power of a signal over time.

Capture Buffer
The Capture Buffer result display shows the complete range of captured data for the last data capture. The x-axis represents time. The maximum value of the x-axis is equal to the Capture Time. The y-axis represents the amplitude of the captured I/Q data in dBm (for RF input).
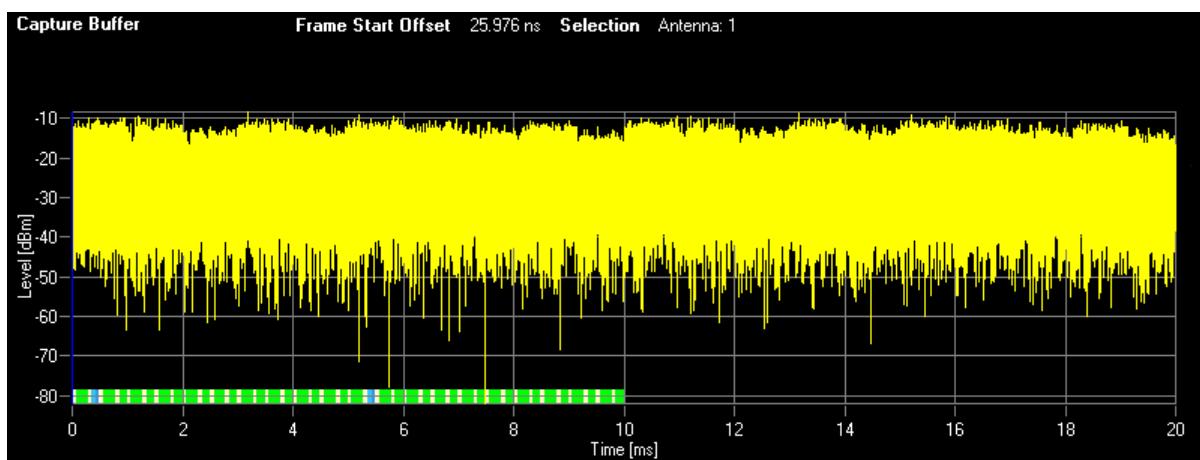
Fig. 3-1: Capture buffer without zoom

The bar at the bottom of the diagram represents the frame that is currently analyzed. Different colors indicate the OFDM symbol type.

-

  Indicates the data stream.
-

  Indicates the reference signal and data.
-

  Indicates the P-SYNC and data.
-

  Indicates the S-SYNC and data.

A blue vertical line at the beginning of the green bar in the Capture Buffer display represents the subframe start. Additionally, the diagram contains the "Start Offset" value. This value is the time difference between the subframe start and capture buffer start.

When you zoom into the diagram, you will see that the bar may be interrupted at certain positions. Each small bar indicates the useful parts of the OFDM symbol.
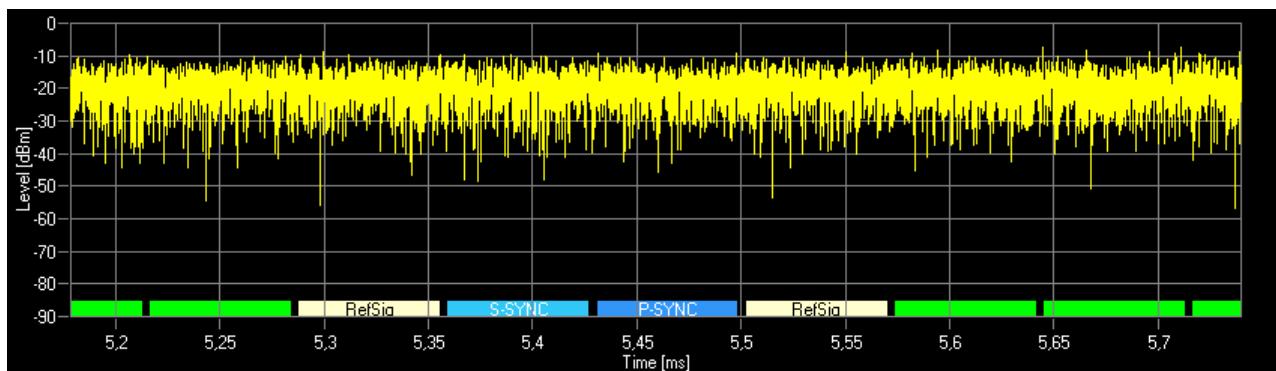
Fig. 3-2: Capture buffer after a zoom has been applied to a downlink signal

Remote command:
CALCulate<n>:FEED 'PVT:CBUF'
TRACe:DATA?
Querying the subframe start offset:
FETCh:SUMMary:TFRame? on page 139

On / Off Power

The On / Off Power measurement shows the characteristics of an LTE TDD signal over time.

The transition from transmission to reception is an issue in TDD systems. Therefore, the measurement is available for TDD signals.

The measurement is designed to verify if the signal intervals during which no downlink signal is transmitted (reception or "off" periods) complies with the limits defined by 3GPP. Because the transition from transmission ("on" periods) to reception has to be very fast in order to efficiently use the resources, 3GPP has also defined limits for the transient periods. The limits for these are also verified by the measurement.

Note that the measurement works only if you are using the RF input. When you start the measurement, the software records new I/Q data instead of using the data other I/Q measurements are based on.

For more information on setting up the measurement see chapter 8.6, "Performing Transmit On/Off Power Measurements", on page 123.

The result display for the On / Off Power measurement consists of numerical results and the graphic display of the signal characteristics.

Numerical results

The upper part of the result display shows the results in numerical form.

Each line in the table shows the measurement results for one "off" period.

ON/OFF Power

Start OFF Period Limit	Stop OFF Period Limit	Time at Δ to Limit	OFF Power Abs [dBm]	OFF Power Δ to Limit	Falling Trans. Period	Rising Trans. Period
1,267 ms	4,948 ms	3,304460 ms	-80,11	5,11 dB	1,95 us	2,67 us
6,267 ms	9,948 ms	6,897558 ms	-80,14	5,14 dB	2,18 us	2,54 us

- Start OFF Period Limit
  Shows the beginning of the "off" period relative to the frame start (0 seconds).
- Stop OFF Period Limit
  Shows the end of the "off" period relative to the frame start (0 seconds).
  The time from the start to the stop of the "off" period is the period over which the limits are checked. It corresponds to the yellow trace in the graphic result display.
- Time at Δ to Limit
  Shows the trace point at which the lowest distance between trace and limit line has been detected. The result is a time relative to the frame start.
- OFF Power Abs [dBm]
  Shows the absolute power of the signal at the trace point with the lowest distance to the limit line.
- OFF Power Δ to Limit
  Shows the distance between the trace and the limit line of the trace point with the lowest distance to the limit line in dB.
- Falling Transition Period
  Shows the length of the falling transient.
- Rising Transition Period
  Shows the length of the rising transient.

Note that the beginning and end of a transition period is determined based on the "Off Power Density Limit". This limit is defined by 3GPP in TS 36.141 as the maximum allowed mean power spectral density. The length of the transient from "on" to "off" period is, for example, the distance from the detected end of the subframe to the last time that the signal power is above the measured mean power spectral density.
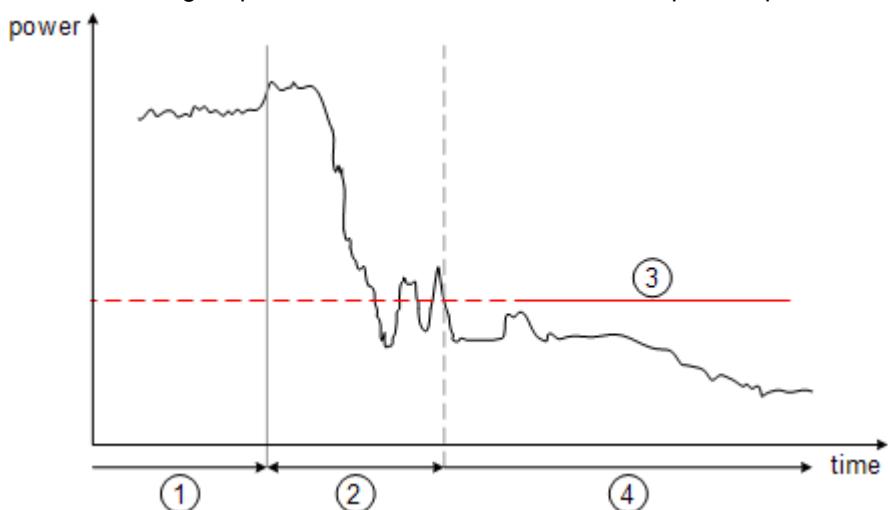
Fig. 3-3: Power profile of an TD-LTE On-to-Off transition. The transition lasts from the end of the OFF period until the signal is completely below the Off Power Density limit.

1 = subframe ("on" power period)
2 = transient (transition length)
3 = "off" power density limit
4 = "off" power period

The diagram contains an overall limit check result (Pass / Fail message). Only if all "off" periods (including the transients) comply to the limits, the overall limit check will pass.

Any results in the table that violate the limits defined by 3GPP are displayed in red.

Graphic results

The lower part of the result display shows a graphical representation of the analyzed TDD frame(s).
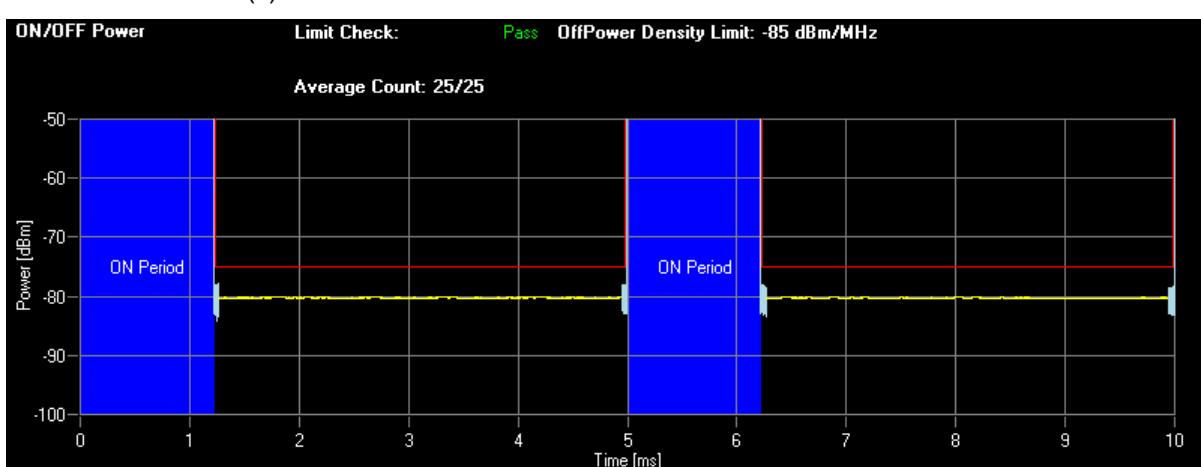
The diagram contains several elements.

● Yellow trace

The yellow trace represents the signal power during the "off" periods. Filtering as defined in 3GPP TS 36.141 is taken into account for the calculation of the trace.
● Blue trace
  The blue trace represents the transition periods (falling and rising).
  Note that the blue trace might be visible only after zooming into the diagram because of its steep flank and small horizontal dimensions.
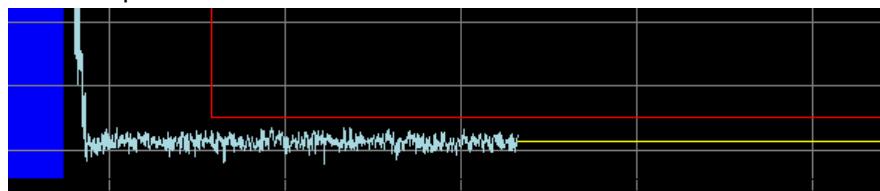
● Blue rectangles
  The blue rectangles represent the "on" periods. Because of the overload during the "on" periods, the actual signal power is only hinted at, not shown.
● Red lines
  Limits as defined by 3GPP.

In addition to these elements, the diagram also shows the overall limit check (see above), the average count and the limit for the mean power spectral density ("Off Power Density Limit").

Remote command:
Selection:
CALCulate<n>:FEED 'PVT:OOP'
Limit check:
CALCulate<n>:LIMit<k>:OOPower:OFFPower? on page 157
CALCulate<n>:LIMit<k>:OOPower:TRANsient? on page 157
[SENSe][:LTE]:OOPower:ATIMing on page 132
TRACe:DATA?

Power vs Symbol x Carrier
The Power vs Symbol x Carrier shows the power for each carrier in each symbol.

The horizontal axis represents the symbols. The vertical axis represents the carriers. Different colors in the diagram area represent the power. The color map for the power levels is provided above the diagram area.
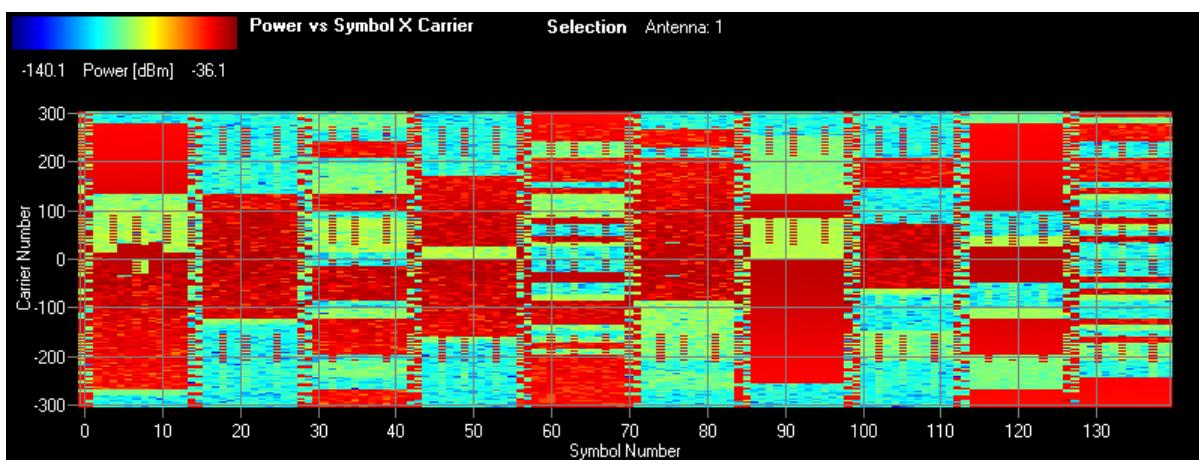
Remote command:

CALCulate<n>:FEED 'STAT:PVSC'
TRACe:DATA?

Time Alignment Error

Starts the Time Alignment Error result display.

The time alignment is an indicator of how well the transmission antennas in a MIMO system are synchronized. The Time Alignment Error is the time delay between a reference antenna (for example antenna 1) and another antenna. For more information see chapter 8.5, "Performing Time Alignment Measurements", on page 121.

The software shows the results in a table.

Each row in the table represents one antenna. The reference antenna is not shown.

For each antenna the maximum, minimum and average time delay that has been measured is shown. The minimum and maximum results are calculated only if the measurement covers more than one frame.

If you perform the measurement on a system with carrier aggregation, each row represents one antenna. The number of lines increases because of multiple carriers. The reference antenna of the main component carrier (CC1) is not shown. In case of carrier aggregation, the result display also evaluates the frequency error of the component carrier (CC2) relative to the main component carrier (CC1). For more information on configuring this measurement see chapter 4.1.6, "Configuring Time Alignment Measurements", on page 69.

Time Alignment Error	Reference Antenna: Antenna 1 (CC1)	Frequency Error to CC1: -0,05 Hz		
Component Carrier	Antenna	Min	Time Aligment Error to Antenna 1 (CC1) Mean	Max
CC1	Antenna 2	0,00 ns	0,00 ns	0,00 ns
CC2	Antenna 1	-0,07 ns	-0,07 ns	-0,07 ns
CC2	Antenna 2	-0,05 ns	-0,05 ns	-0,05 ns

You can select the reference antenna via "Antenna Selection" in the MIMO Configuration.

When you perform a time alignment measurement, the software also displays the Power Spectrum result display.

Remote command:
CALCulate<screenid>:FEED 'PVT:TAER'
FETCh:TAERror[:CC<cci>]:ANTenna<antenna>[:AVERage]? on page 140
CONFigure[:LTE]:DL[:CC<cci>]:MIMO:ASELection on page 187
FETCh[:CC<cci>]:SUMMary:RFERror:AVERage? on page 138

3.3 Measuring the Error Vector Magnitude (EVM)

This chapter contains information on all measurements that show the error vector magnitude (EVM) of a signal.

The EVM is one of the most important indicators for the quality of a signal. For more information on EVM calculation methods refer to chapter 8, "Measurement Basics", on page 112.

EVM vs Carrier
Starts the EVM vs Carrier result display.

This result display shows the Error Vector Magnitude (EVM) of the subcarriers. With the help of a marker, you can use it as a debugging technique to identify any subcarriers whose EVM is too high.

The results are based on an average EVM that is calculated over the resource elements for each subcarrier. This average subcarrier EVM is determined for each analyzed subframe in the capture buffer.

If you analyze all subframes, the result display contains three traces.
- Average EVM
  This trace shows the subcarrier EVM averaged over all subframes.
- Minimum EVM
  This trace shows the lowest (average) subcarrier EVM that has been found over the analyzed subframes.
- Maximum EVM
  This trace shows the highest (average) subcarrier EVM that has been found over the analyzed subframes.

If you select and analyze one subframe only, the result display contains one trace that shows the subcarrier EVM for that subframe only. Average, minimum and maximum values in that case are the same. For more information see "Subframe Selection" on page 68

The x-axis represents the center frequencies of the subcarriers. On the y-axis, the EVM is plotted either in % or in dB, depending on the EVM Unit.
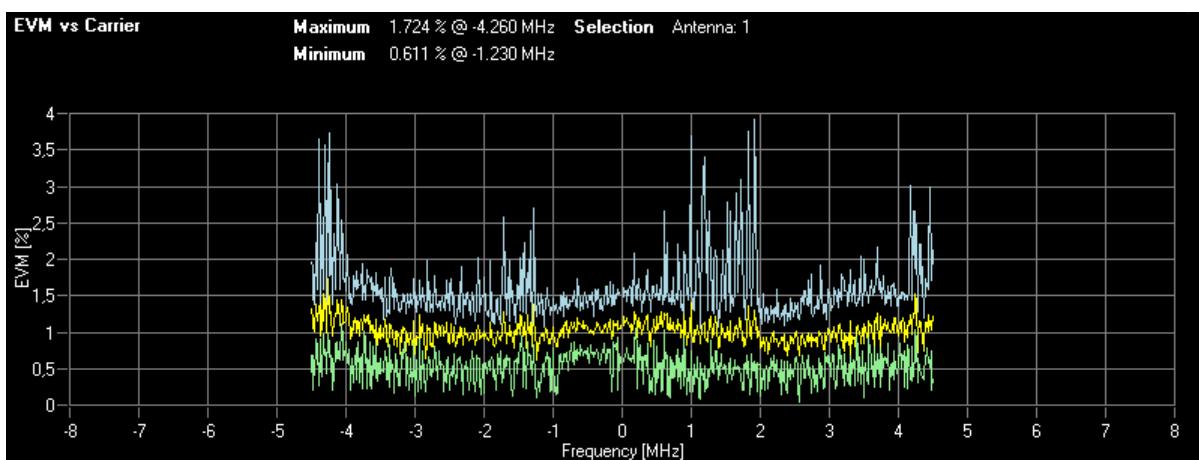
Remote command:
CALCulate<n>:FEED 'EVM:EVCA'
TRACe:DATA?

EVM vs Symbol
Starts the EVM vs Symbol result display.

This result display shows the Error Vector Magnitude (EVM) of the OFDM symbols. You can use it as a debugging technique to identify any symbols whose EVM is too high.

The results are based on an average EVM that is calculated over all subcarriers that are part of a particular OFDM symbol. This average OFDM symbol EVM is determined for all OFDM symbols in each analyzed subframe.

If you analyze all subframes, the result display contains three traces.
● Average EVM
  This trace shows the OFDM symbol EVM averaged over all subframes.
● Minimum EVM
  This trace shows the lowest (average) OFDM symbol EVM that has been found over the analyzed subframes.
● Maximum EVM
  This trace shows the highest (average) OFDM symbol EVM that has been found over the analyzed subframes.

If you select and analyze one subframe only, the result display contains one trace that shows the OFDM symbol EVM for that subframe only. Average, minimum and maximum values in that case are the same. For more information see "Subframe Selection" on page 68

The x-axis represents the OFDM symbols, with each symbol represented by a dot on the line. The number of displayed symbols depends on the Subframe Selection and the length of the cyclic prefix. Any missing connections from one dot to another mean that the software could not determine the EVM for that symbol. In case of TDD signals, the result display does not show OFDM symbols that are not part of the measured link direction.

On the y-axis, the EVM is plotted either in % or in dB, depending on the EVM Unit
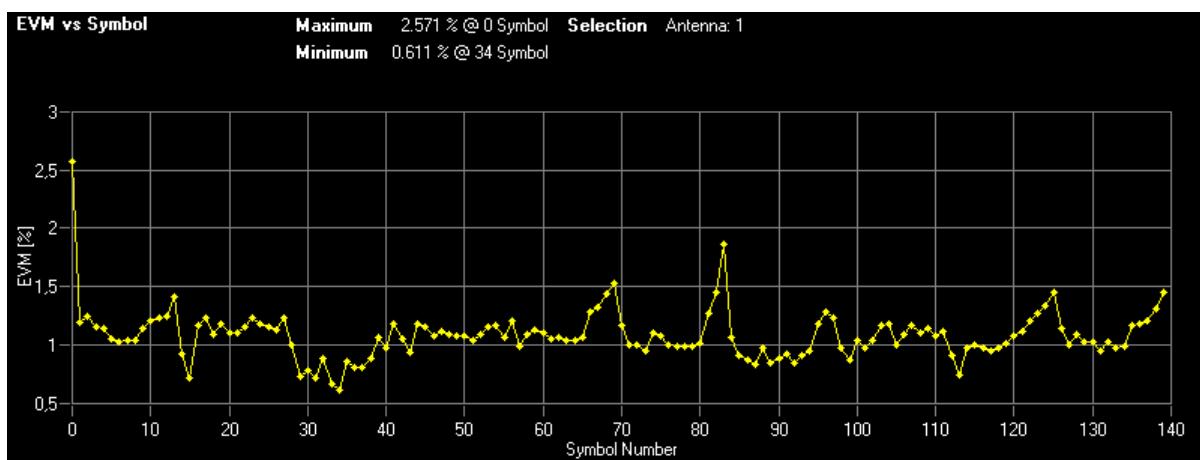
Remote command:
CALCulate<n>:FEED 'EVM:EVSY'
TRACe:DATA?

EVM vs Sym x Carr

The EVM vs Symbol x Carrier shows the EVM for each carrier in each symbol.

The horizontal axis represents the symbols. The vertical axis represents the carriers. Different colors in the diagram area represent the EVM. The color map for the power levels is provided above the diagram area.
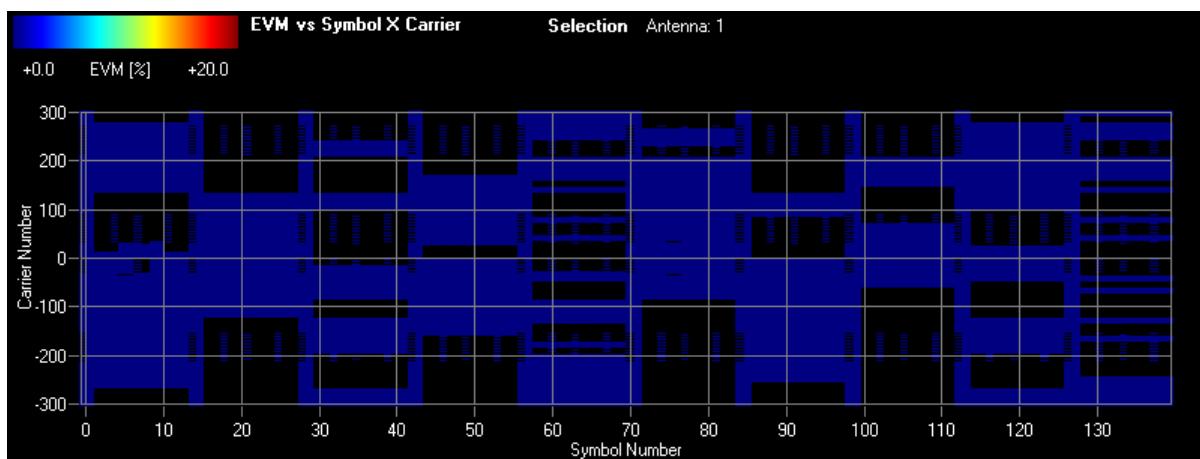
Remote command:
CALCulate<n>:FEED 'EVM:EVSC'
TRACe:DATA?

EVM vs RB

Starts the EVM vs RB result display.

This result display shows the Error Vector Magnitude (EVM) for all resource blocks that can be occupied by the PDSCH.

The results are based on an average EVM that is calculated over all resource elements in the resource block. This average resource block EVM is determined for each analyzed subframe.

If you analyze all subframes, the result display contains three traces.

● Average EVM
This trace shows the resource block EVM averaged over all subframes.
● Minimum EVM
This trace shows the lowest (average) resource block EVM that has been found over the analyzed subframes.
● Maximum EVM
This trace shows the highest (average) resource block EVM that has been found over the analyzed subframes.

If you select and analyze one subframe only, the result display contains one trace that shows the resource block EVM for that subframe only. Average, minimum and maximum values in that case are the same. For more information see "Subframe Selection" on page 68

The x-axis represents the PDSCH resource blocks. On the y-axis, the EVM is plotted either in % or in dB, depending on the EVM Unit.
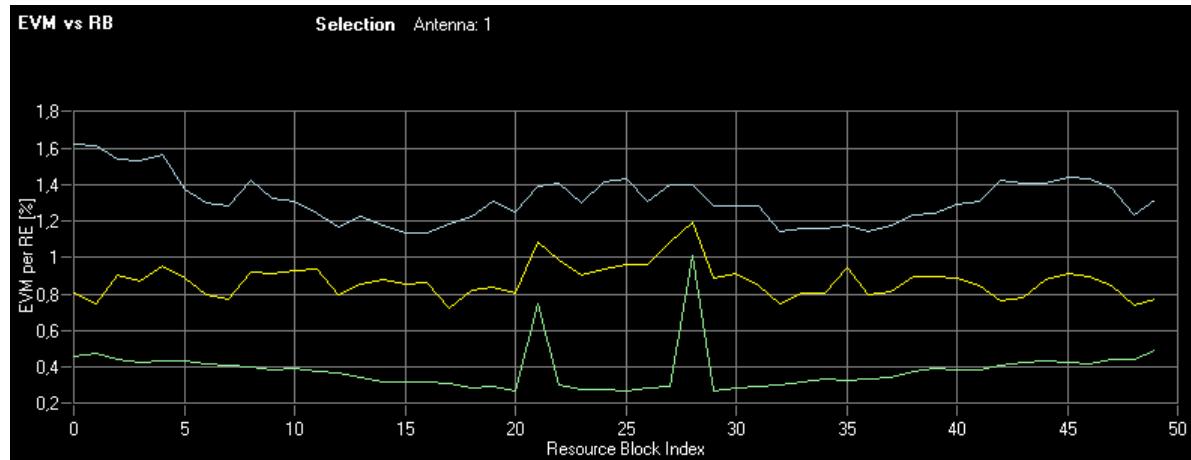
Remote command:
CALCulate<n>:FEED 'EVM:EVRP'
TRACe:DATA?

EVM vs Subframe
Starts the EVM vs Subframe result display.

This result display shows the Error Vector Magnitude (EVM) for each subframe. You can use it as a debugging technique to identify a subframe whose EVM is too high.

The result is an average over all subcarriers and symbols of a specific subframe.

The x-axis represents the subframes, with the number of displayed subframes being 10.

On the y-axis, the EVM is plotted either in % or in dB, depending on the EVM Unit.
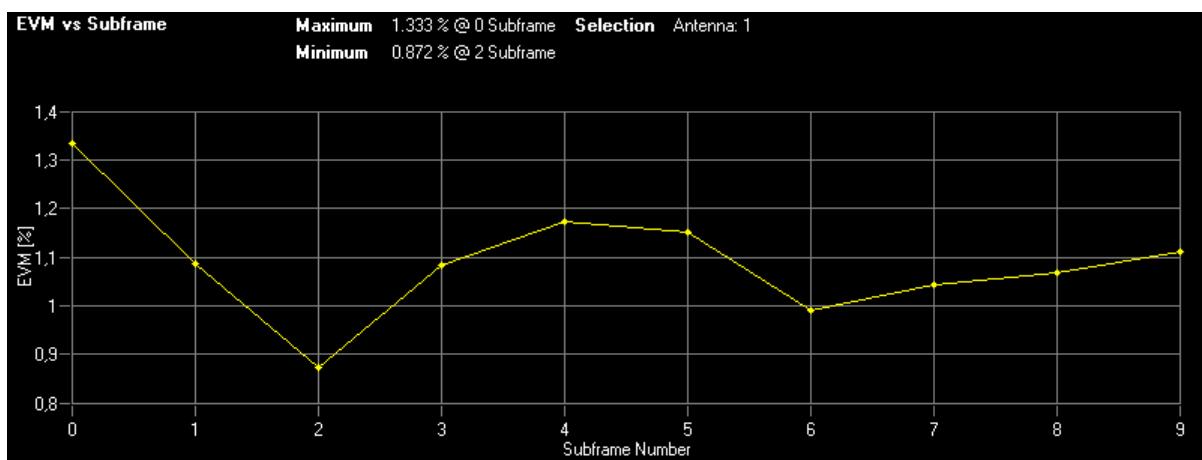
Remote command:
CALCulate<n>:FEED 'EVM:EVSU'
TRACe:DATA?

Frequency Error vs Symbol
Starts the Frequency Error vs Symbol result display.

This result display shows the Frequency Error on symbol level. You can use it as a debugging technique to identify any frequency errors within symbols.

The result is an average over all subcarriers.

The x-axis represents the OFDM symbols. The number of displayed symbols depends on the Subframe Selection and the length of the cyclic prefix. On the y-axis, the frequency error is plotted in Hz.
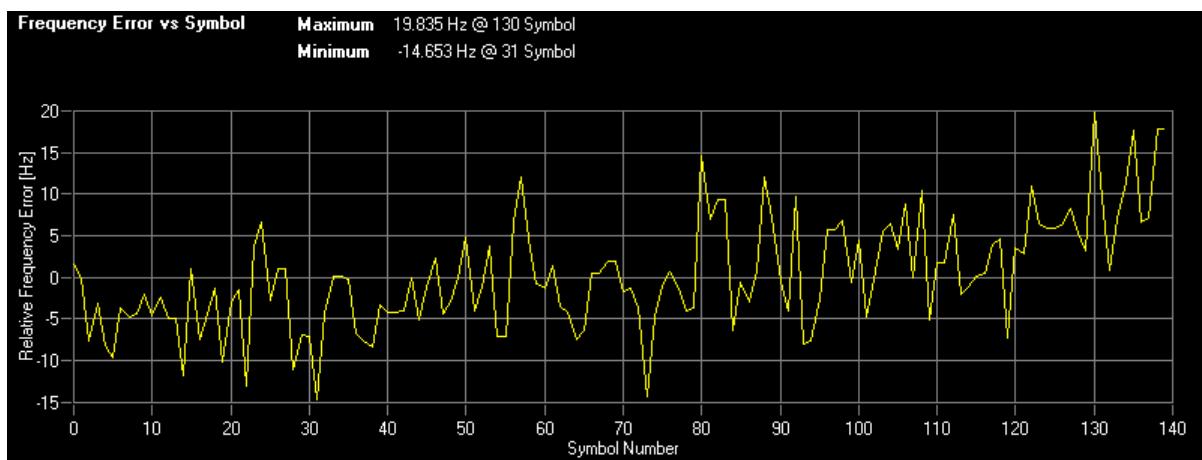
Remote command:
CALCulate<n>:FEED 'EVM:FEVS'
TRACe:DATA?

3.4   Measuring the Spectrum

This chapter contains information on all measurements that show the power of a signal in the frequency domain.

In addition to the I/Q measurements, spectrum measurements also include two frequency sweep measurements, the Spectrum Emission Mask and the Adjacent Channel Leakage Ratio.

3.4.1   Frequency Sweep Measurements

The Spectrum Emission Mask (SEM) and Adjacent Channel Leakage Ratio (ACLR) measurements are the only frequency sweep measurements available for the EUTRA/ LTE measurement software. They do not use the I/Q data all other measurements use. Instead those measurements sweep the frequency spectrum every time you run a new measurement. Therefore it is not possible to to run an I/Q measurement and then view the results in the frequency sweep measurements and vice-versa. Also because each of the frequency sweep measurements uses different settings to obtain signal data it is not possible to run a frequency sweep measurement and view the results in another frequency sweep measurement.

Frequency sweep measurements are available if RF input is selected.

Note that unwanted emissions measurements (for example the ACLR) are not supported for measurements with an oscilloscope.

Spectrum Mask
Starts the Spectrum Emission Mask (SEM) result display.

The Spectrum Emission Mask measurement shows the quality of the measured signal by comparing the power values in the frequency range near the carrier against a spectral mask that is defined by the 3GPP specifications. In this way, you can test the performance of the DUT and identify the emissions and their distance to the limit.

In the diagram, the SEM is represented by a red line. If any measured power levels are above that limit line, the test fails. If all power levels are inside the specified limits, the test is passed. The software labels the limit line to indicate whether the limit check has passed or failed.

The x-axis represents the frequency with a frequency span that relates to the specified EUTRA/LTE channel bandwidths. On the y-axis, the power is plotted in dBm.

The result display also contains some numerical results for the SEM measurement, for example the total signal power or the limit check result.
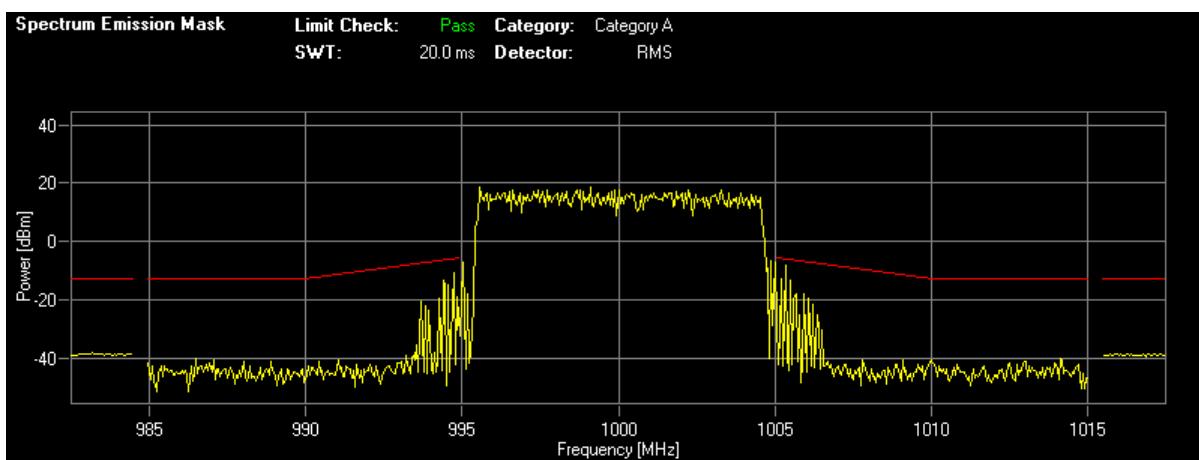
A table above the result display contains the numerical values for the limit check at each check point:

- **Start / Stop Freq Rel**
  Shows the start and stop frequency of each section of the Spectrum Mask relative to the center frequency.
- **RBW**
  Shows the resolution bandwidth of each section of the Spectrum Mask
- **Freq at Δ to Limit**
  Shows the absolute frequency whose power measurement being closest to the limit line for the corresponding frequency segment.
- **Power Abs**
  Shows the absolute measured power of the frequency whose power is closest to the limit. The software evaluates this value for each frequency segment.
- **Power Rel**
  Shows the distance from the measured power to the limit line at the frequency whose power is closest to the limit. The software evaluates this value for each frequency segment.
- **Δ to Limit**
  Shows the minimal distance of the tolerance limit to the SEM trace for the corresponding frequency segment. Negative distances indicate the trace is below the tolerance limit, positive distances indicate the trace is above the tolerance limit.

Spectrum Emission Mask List

Start Freq. Rel.	Stop Freq. Rel.	RBW	Freq. at Δ to Limit	Pwr Abs [dBm]	Pwr Rel [dB]	Δ to Limit [dB]
-17,50 MHz	-15,50 MHz	1,00 MHz	0,983173100 GHz	-38,26	-72,55	-25,26
-15,05 MHz	-10,05 MHz	0,10 MHz	0,986482400 GHz	-40,14	-74,44	-27,64
-10,05 MHz	-5,05 MHz	0,10 MHz	0,994727600 GHz	-10,81	-45,10	-5,00
5,05 MHz	10,05 MHz	0,10 MHz	1,005329000 GHz	-8,12	-42,41	-2,23
10,05 MHz	15,05 MHz	0,10 MHz	1,014135000 GHz	-40,14	-74,43	-27,64
15,50 MHz	17,50 MHz	1,00 MHz	1,016266000 GHz	-38,40	-72,70	-25,40

Remote command:
CALCulate<n>:FEED 'SPEC:SEM'
TRACe:DATA?

ACLR

Starts the Adjacent Channel Leakage Ratio (ACLR) measurement.

The ACLR measurement analyzes the power of the transmission (TX) channel and the power of the two neighboring channels (adjacent channels) to the left and right of the TX channel. Thus, the ACLR measurement provides information about the power in the adjacent channels as well as the leakage into these adjacent channels.

The software shows two traces, a yellow one (T1) and a green one (T2). The yellow trace is the representation of the signal data measured with a resolution bandwidth (RBW) of 1 MHz. The green trace is the data measured with a RBW of 100 kHz.

The x-axis represents the frequency with a frequency span that relates to the specified EUTRA/LTE channel and adjacent bandwidths. On the y-axis, the power is plotted in dBm.

By default the ACLR settings are based on the selected LTE Channel Bandwidth. You can change the assumed adjacent channel carrier type and the Noise Correction.
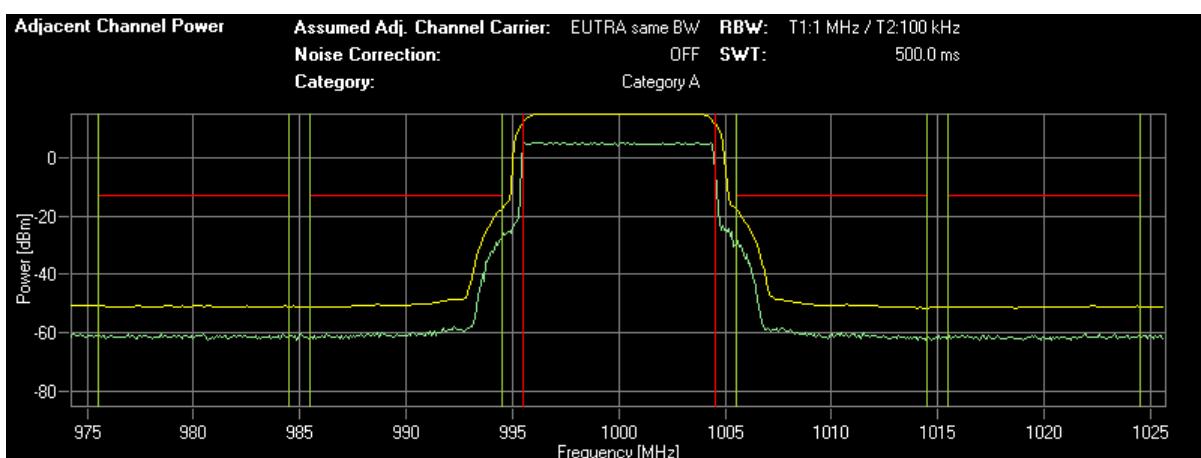
The software provides a relative and an absolute ACLR measurement mode that you can select with the "ACLR (REL ABS)" softkey.

- In case of the relative measurement mode, the power for the TX channel is an absolute value in dBm. The power of the adjacent channels are values relative to the power of the TX channel.
- In case of the absolute measurement mode, the power for both TX and adjacent channels are absolute values in dBm.

In addition, the ACLR measurement results are also tested against the limits defined by 3GPP. In the diagram, the limits are represented by horizontal red lines.

The software performs two types of limit check.

- The limit check for the limits defined for the channel power of each adjacent channel. The channel power limit check is based on the green trace.
- The minimum distance of the actual power to the limit line in each channel. In addition to the distance (in dB), the software also shows the frequency at which the minimum distance has been measured in each channel.
  The distance to the limit line is measured for the yellow trace.

The limit check result evaluates both types of limit check. If one or both of the limit checks in each channel has passed, the overall limit check for that channel also passes. If both limit checks fail, the overall limit check for that channel also fails.

ACLR table

A table above the result display contains information about the measurement in numerical form:

● **Channel**
  Shows the channel type (TX, Adjacent or Alternate Channel).
● **Bandwidth**
  Shows the bandwidth of the channel.
● **Spacing**
  Shows the channel spacing.
● **Channel Power**
  Shows the absolute or relative power of the corresponding channel.
● **Δ to Limit [dB]**
  Shows the minimum distance to the limit line in the corresponding channel.
● **Frequency at Δ to Limit [GHz]**
  Shows the frequency of the trace point with the minimum distance to the limit line in the corresponding channel.
● **Overall Limit Check**
  Shows the overall limit check results.
  PASS indicates a positive result, FAIL a negative result.

Adj. Chan. Leakage Power Ratio List	Limit Adjacent: -45 dB Limit Alternate: -45 dB					
Channel	**Bandwidth**	**Spacing (Offset)**	**Channel Power**	**Δ to Limit [dB]**	**Frequency at Δ to Limit [GHz]**	**Overall Limit Check**
TX	9,015 MHz		23,99 dBm			
Lower Adj	9,015 MHz	-10 MHz	-46,39 dB	-5,13	+0,994413952	PASS
Upper Adj	9,015 MHz	10 MHz	-46,72 dB	-4,53	+1,005494720	PASS
Lower Alt	9,015 MHz	-20 MHz	-66,01 dB	-37,69	+0,980143296	PASS
Upper Alt	9,015 MHz	20 MHz	-66,23 dB	-37,84	+1,022283776	PASS

Remote command:
Selection:
CALCulate<n>:FEED 'SPEC:ACP'
Limit check:
CALCulate<n>:LIMit<k>:ACPower:ACHannel:RESult? on page 155
CALCulate<n>:LIMit<k>:ACPower:ALTernate:RESult? on page 155
Reading results:
CALCulate<n>:MARKer<m>:FUNCtion:POWer:RESult[:CURRent]?
on page 156
TRACe:DATA?

3.4.2 I/Q Measurements

Power Spectrum

Starts the Power Spectrum result display.

This result display shows the power density of the complete capture buffer in dBm/Hz. The displayed bandwidth depends on bandwidth or number of resource blocks you have set.

For more information see "Channel Bandwidth / Number of Resource Blocks" on page 87.

The x-axis represents the frequency. On the y-axis the power level is plotted.
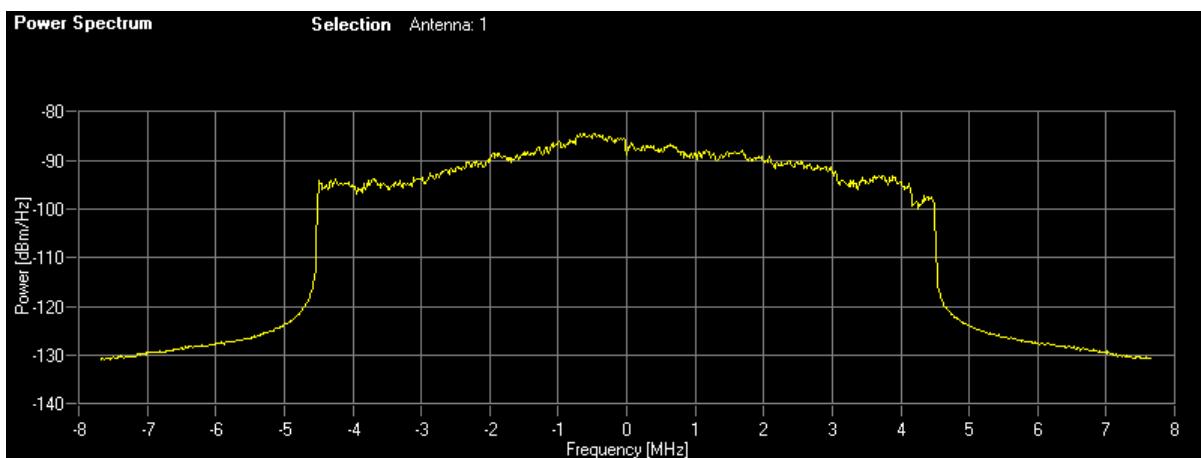
Remote command:
CALCulate<screenid>:FEED 'SPEC:PSPE'
TRACe:DATA?

Power vs Resource Block PDSCH

Starts the Power vs Resource Block PDSCH result display.

This result display shows the power of the physical downlink shared channel per resource block.

By default, three traces are shown. One trace shows the average power. The second and the third trace show the minimum and maximum powers respectively. You can select to display the power for a specific subframe in the Subframe Selection dialog box. In that case, the application shows the powers of that subframe only.

The x-axis represents the resource blocks. The displayed number of resource blocks depends on the channel bandwidth or number of resource blocks you have set. On the y-axis, the power is plotted in dBm.
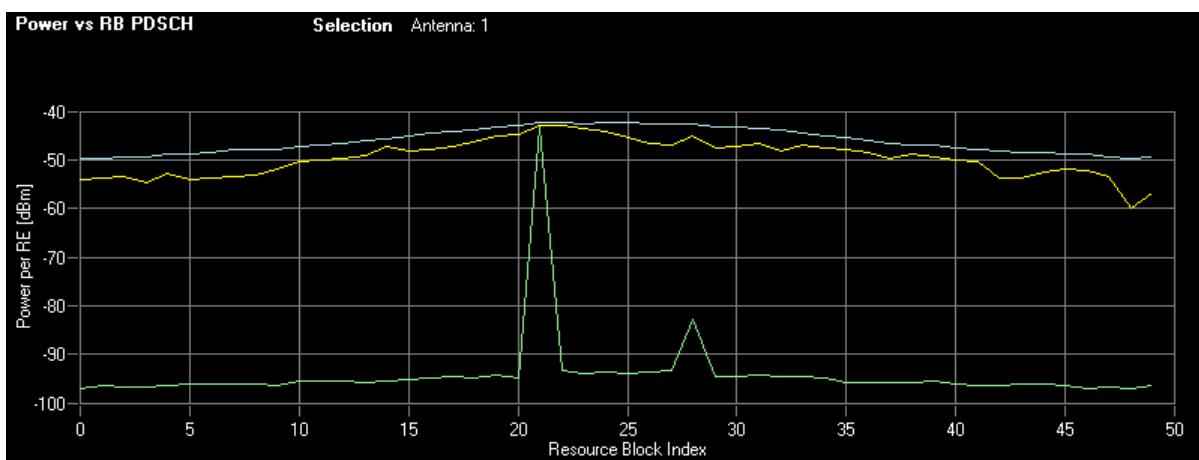
Remote command:
CALCulate<n>:FEED 'SPEC:PVRP'
TRACe:DATA?

Power vs Resource Block RS
Starts the Power vs Resource Block RS result display.

This result display shows the power of the reference signal per resource block.

By default, three traces are shown. One trace shows the average power. The second and the third trace show the minimum and maximum powers respectively. You can select to display the power for a specific subframe in the Subframe Selection dialog box. In that case, the application shows the power of that subframe only.

The x-axis represents the resource blocks. The displayed number of resource blocks depends on the channel bandwidth or number of resource blocks you have set. On the y-axis, the power is plotted in dBm.
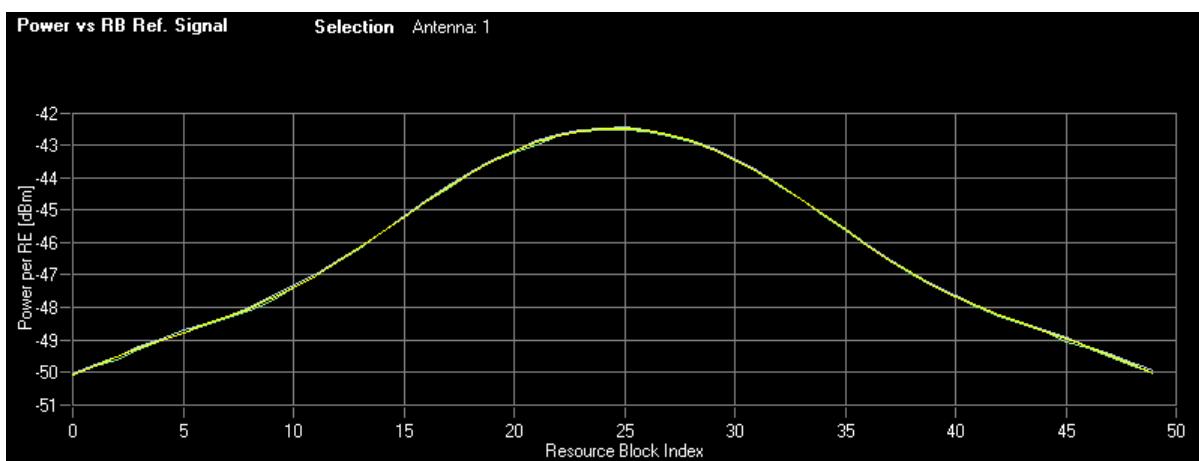
Remote command:
CALCulate<n>:FEED 'SPEC:PVRR'
TRACe:DATA?

Channel Flatness
Starts the Channel Flatness result display.

This result display shows the relative power offset caused by the transmit channel.

The currently selected subframe depends on your selection.

The x-axis represents the frequency. On the y-axis, the channel flatness is plotted in dB.
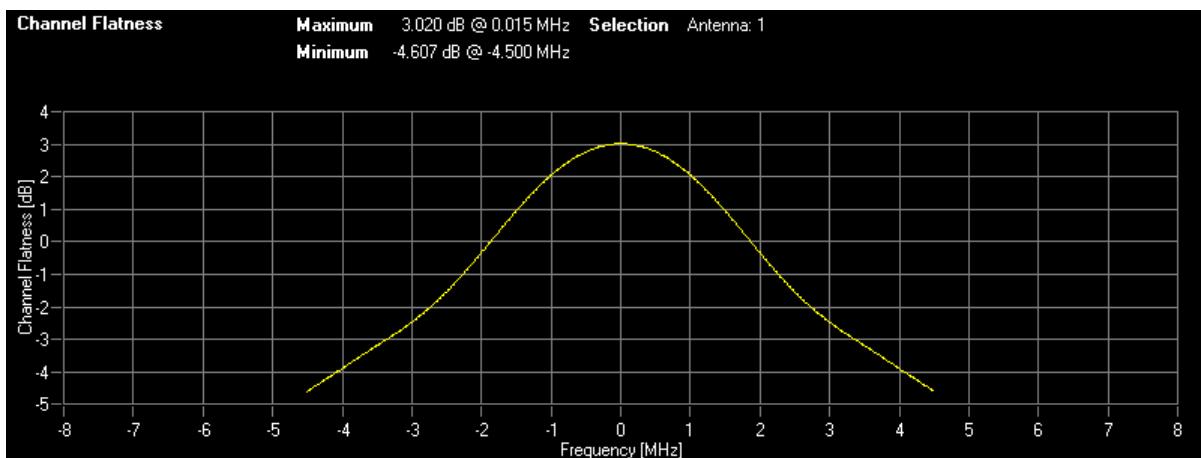
Remote command:
CALCulate<n>:FEED 'SPEC:FLAT'
TRACe:DATA?

Channel Flatness Difference
Starts the Channel Flatness Difference result display.

This result display shows the level difference in the spectrum flatness result between two adjacent physical subcarriers.

The currently selected subframe depends on your selection.

The x-axis represents the frequency. On the y-axis, the power is plotted in dB.
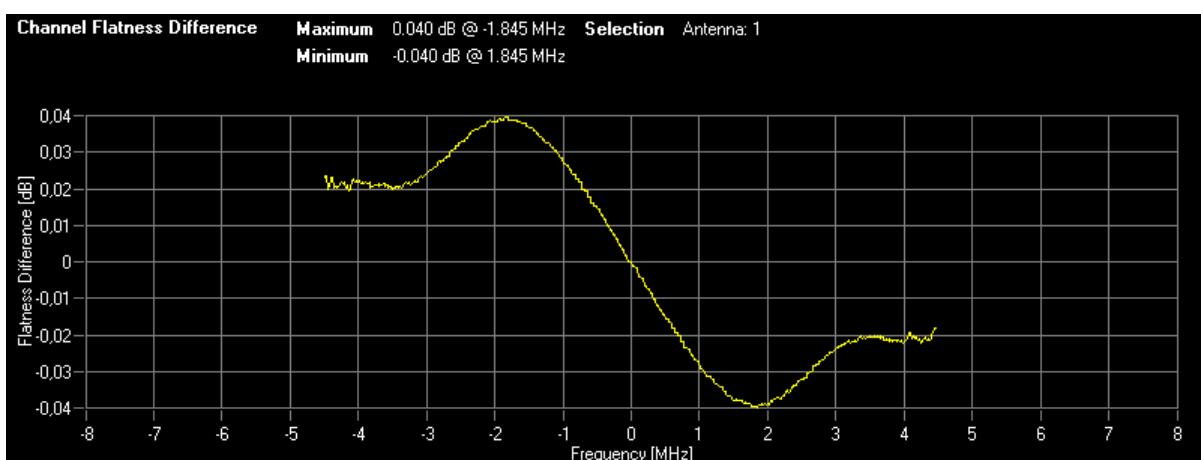
Remote command:
CALCulate<n>:FEED 'SPEC:FDIF'
TRACe:DATA?

Channel Group Delay
Starts the Channel Group Delay result display.

This result display shows the group delay of each subcarrier.

The currently selected subframe depends on your selection.

The x-axis represents the frequency. On the y-axis, the group delay is plotted in ns.
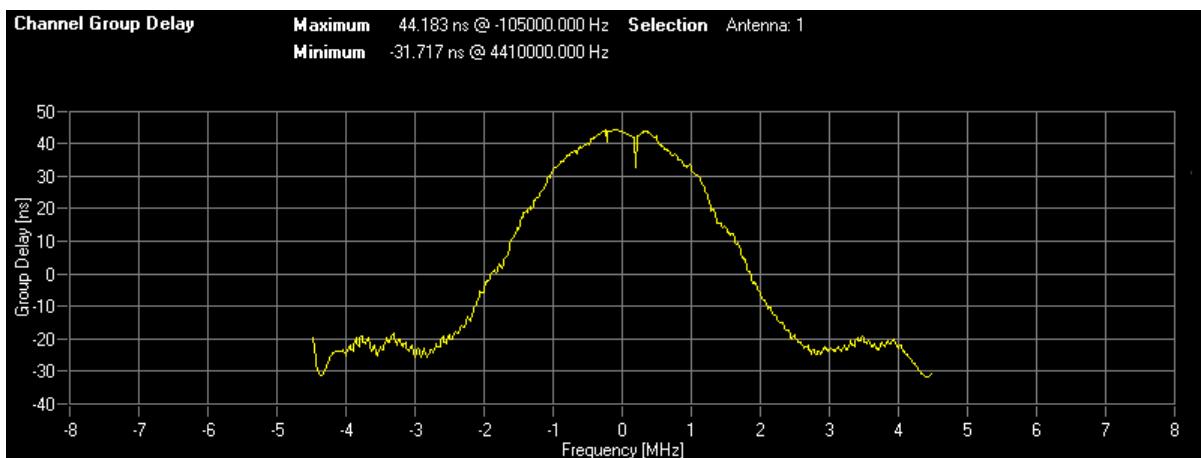
Remote command:
CALCulate<n>:FEED 'SPEC:GDEL'
TRACe:DATA?

3.5 Measuring the Symbol Constellation

This chapter contains information on all measurements that show the constellation of a signal.

Constellation Diagram
Starts the Constellation Diagram result display.

This result display shows the inphase and quadrature phase results and is an indicator of the quality of the modulation of the signal.

In the default state, the result display evaluates the full range of the measured input data. You can filter the results in the Constellation Selection dialog box.

The ideal points for the selected modulation scheme are displayed for reference purposes.
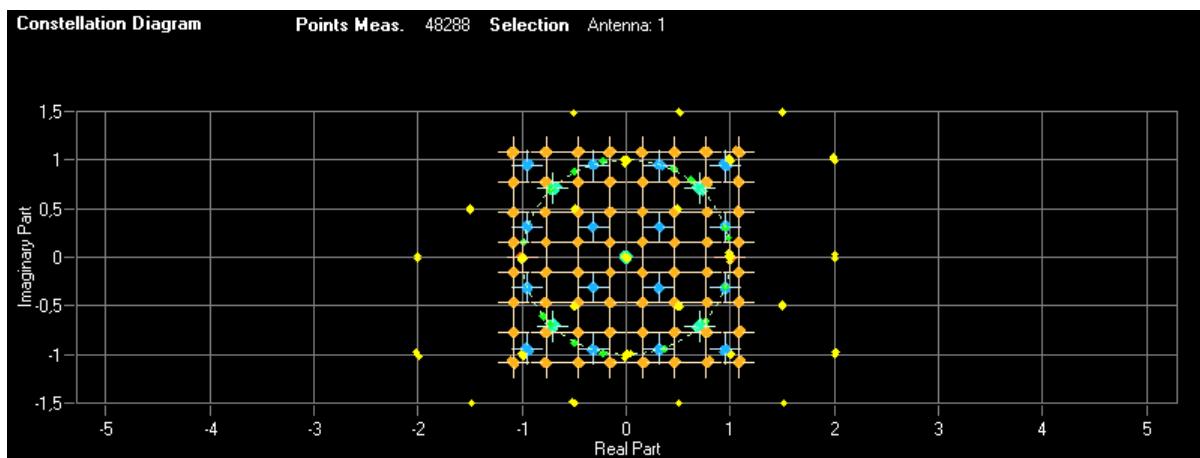
The constellation diagram also contains information about the current evaluation range. In addition, it shows the number of points that are displayed in the diagram.

Remote command:
CALCulate<n>:FEED 'CONS:CONS'
TRACe:DATA?

Evaluation Range for the Constellation Diagram
The "Evaluation Range" dialog box defines the type of constellation points that are displayed in the Constellation Diagram.

By default the software displays all constellation points of the data that have been evaluated. However, you can filter the results by several aspects.
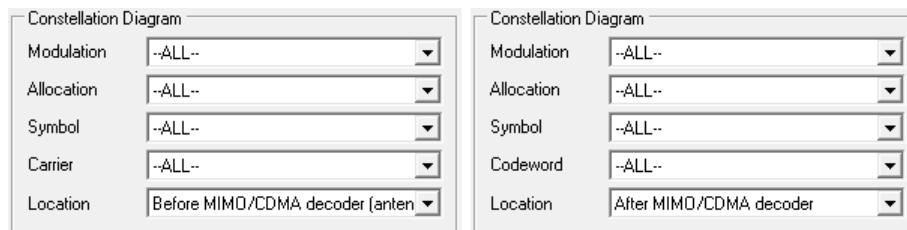
Fig. 3-4: Evaluation range for constellations before and after MIMO decoding

- Modulation
  Filters the results to include only the selected type of modulation.
- Allocation
  Filters the results to include only a particular type of allocation.
- Symbol
  Filters the results to include only a particular OFDM symbol.
  Filtering by OFDM symbols is available for constellations created before MIMO decoding.
- Carrier
  Filters the results to include only a particular subcarrier.
  Filtering by carrier is available for constellations created before MIMO decoding.
- Symbol
  Filters the results to include only a particular codeword symbol.

Filtering by codeword symbols is available for constellations created after MIMO decoding.

- Codeword
Filters the results to include only a particular codeword.
Filtering by codeword is available for constellations created after MIMO decoding.
- Location
Selects the point in the signal processing at which the constellation diagram is created, before or after the MIMO encoding.
In case of spatial multiplexing, symbols of different encoding schemes are merged in the MIMO encoder. Thus you get a mix of different modulation alphabets. When you filter these symbols to show a modulation "MIXTURE", you get the mixed symbols only if you have selected the "Before MIMO/CDMA Decoder" option.
Note that the PHICH is CDMA encoded. Thus, the constellation points for the PHICH are either created before or after CDMA encoding.
If you have selected "After MIMO/CDMA Decoder", filtering by "Symbol" and "Carrier" is not available.

The result display is updated as soon as you make the changes.

Note that the constellation selection is applied to all windows in split screen mode if the windows contain constellation diagrams.

Remote command:
Location:
`CONFigure[:LTE]:DL:CONS:LOCation` on page 132

3.6 Measuring Statistics

This chapter contains information on all measurements that show the statistics of a signal.

CCDF
Starts the Complementary Cumulative Distribution Function (CCDF) result display.

This result display shows the probability of an amplitude exceeding the mean power. For the measurement, the complete capture buffer is used.

The x-axis represents the power relative to the measured mean power. On the y-axis, the probability is plotted in %.
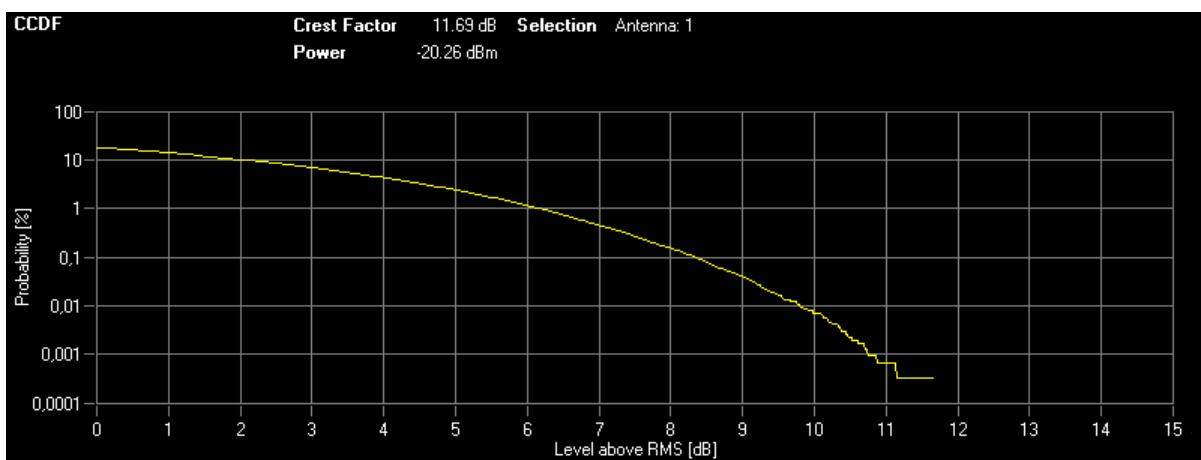
Remote command:
CALCulate<n>:FEED 'STAT:CCDF'
TRACe:DATA?

Signal Flow
Starts the Signal Flow result display.

This result display shows the synchronization status of the current measurement. It also shows the location of the synchronization error in the signal processing.

For each synchronization block, a bar is shown giving information about the reliability of the synchronization result. If the level in the bar falls below the threshold indicated by the horizontal line, the synchronization is marked as failed and the color of the bar changes from green to red. When the synchronization of the block fails, the complete block changes its color to red and all succeeding arrows change their color to red, too.

For more information see chapter 8, "Measurement Basics", on page 112.
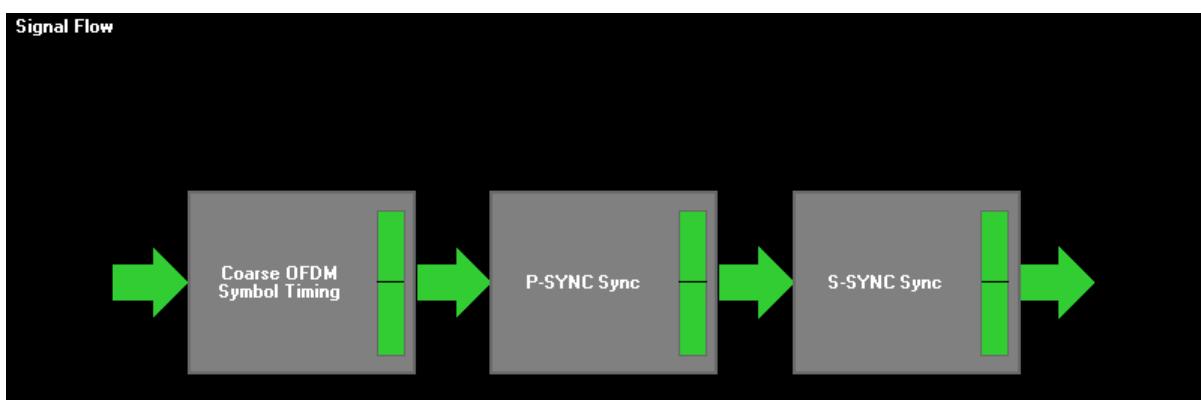
Remote command:
CALCulate<n>:FEED 'STAT:SFLO'

Allocation Summary
Starts the Allocation Summary result display.

This result display shows the results of the measured allocations in tabular form.

Sub-frame	Alloc. ID	Number of RB	Rel. Power/dB	Modulation	Power per RE/dBm	EVM/%
0	RS Ant1		0,000	QPSK	-45,546	1,733
	P-SYNC		-0,007	CAZAC	-42,558	1,254
	S-SYNC		0,005	RBPSK	-42,546	1,251
	PBCH		-0,003	QPSK	-42,579	1,185
	PCFICH		0,000	QPSK	-45,619	2,079
	PHICH		0,000	MIXTURE	-43,984	2,877
	PDCCH		0,001	QPSK	-47,750	1,784
	PDSCH 0	23	-0,001	64QAM	-45,321	1,092
	PDSCH 1	12	0,003	QPSK	-47,871	1,280
	ALL	35				1.333

The rows in the table represent the allocations, with allocation ALL being a special allocation that summarizes all allocations that are part of the subframe. A set of allocations form a subframe. The subframes are separated by a dashed line. The columns of the table contain the following information:

- **Subframe**
  Shows the subframe number.
- **Allocation ID**
  Shows the type / ID of the allocation.
- **Number of RB**
  Shows the number of resource blocks assigned to the current PDSCH allocation.
- **Rel. Power/dB**
  Shows the relative power of the allocation.
- **Modulation**
  Shows the modulation type.
- **Power per RE [dBm]**
  Shows the power of each resource element in dBm.
- **EVM**
  Shows the EVM of the allocation. The unit depends on your selection.

Note: PDSCH allocation with beamforming. The allocation summary shows two entries for a PDSCH allocation that uses "Beamforming (UE spec. RS)" as the precoding method. The second entry shows the measurement results of the UE specific reference signal.

Remote command:
CALCulate<n>:FEED 'STAT:ASUM'
TRACe:DATA?

Bit Stream
Starts the Bit Stream result display.

This result display shows the demodulated data stream for each data allocation. Depending on the Bit Stream Format, the numbers represent either bits (bit order) or symbols (symbol order).

Selecting symbol format shows the bit stream as symbols. In that case the bits belonging to one symbol are shown as hexadecimal numbers with two digits. In the case of bit format, each number represents one raw bit.

Symbols or bits that are not transmitted are represented by a "-".

If a symbol could not be decoded because the number of layers exceeds the number of receive antennas, the application shows a "#" sign.

This is also the case, if PDSCH resource elements are overwritten for any reason. For more information see Overwrite PDSCH and Selecting the Precoding Scheme.

Sub-frame	Allocation ID	Code-word	Modulation	Symbol Index	Bit Stream
0	PBCH	1/1	QPSK	0	01 01 00 02 03 00 01 02 01 02 01 00 03 00 02 02
0	PBCH	1/1	QPSK	16	02 03 02 03 03 03 00 02 00 03 00 02 02 03 01 01
0	PBCH	1/1	QPSK	32	03 02 03 03 03 03 01 03 00 03 00 03 03 00 03 02
0	PBCH	1/1	QPSK	48	00 01 00 01 01 03 01 01 02 03 01 03 01 00 00 03
0	PBCH	1/1	QPSK	64	02 03 02 02 02 00 01 00 02 03 01 03 01 01 02 00
0	PBCH	1/1	QPSK	80	00 01 01 00 02 02 02 01 00 02 03 01 01 01 03 02
0	PBCH	1/1	QPSK	96	02 02 00 02 03 00 03 00 01 03 02 00 03 00 02 03
0	PBCH	1/1	QPSK	112	03 01 01 03 01 01 02 00 03 01 01 01 03 01 03 03
0	PBCH	1/1	QPSK	128	01 03 00 03 02 01 02 03 02 02 02 02 01 02 03 02
0	PBCH	1/1	QPSK	144	03 03 02 02 03 01 02 03 02 02 00 01 02 01 03 00

The table contains the following information:

● **Subframe**
Number of the subframe the bits belong to.
● **Allocation ID**
Channel the bits belong to.
● **Codeword**
Code word of the allocation.
● **Modulation**
Modulation type of the channels.
● **Bit Stream**
The actual bit stream.

Remote command:

CALCulate<n>:FEED 'STAT:BSTR'
TRACe:DATA?

Allocation ID vs Symbol x Carrier
The Allocation ID vs. Symbol X Carrier display shows the allocation ID of each carrier in each symbol of the received signal.
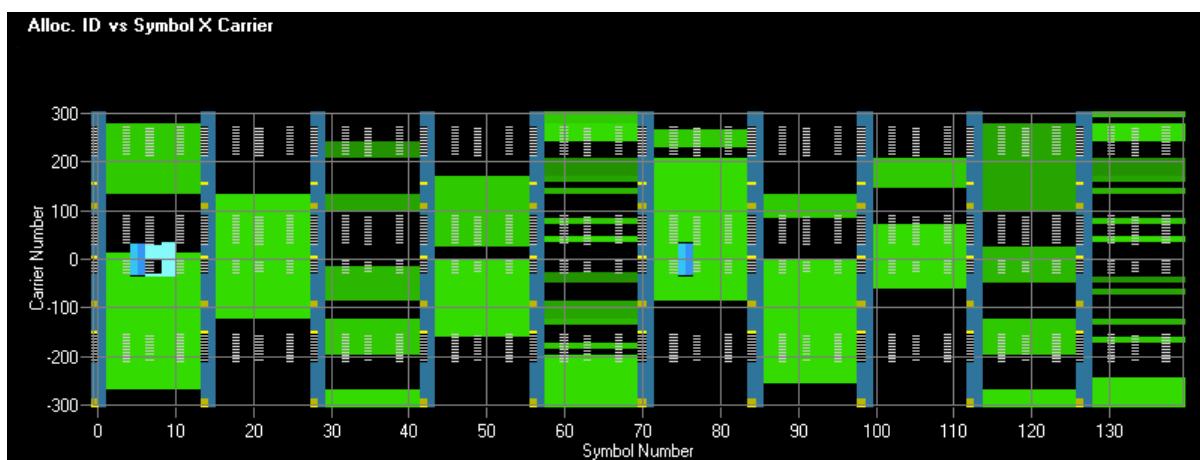
Remote command:
CALCulate<n>:FEED 'STAT:AISC'
TRACe:DATA?

Channel Decoder Results

The Channel Decoder result display is a numerical result display that shows the characteristics of various channels for a particular subframe.

- Protocol information of the PBCH, PCFICH and PHICH.
- Information about the DCIs in the PDCCH.
- Decoded bitstream for each PDCCH.
- Decoded bitstream for each PDSCH.

The size of the table thus depends on the number of subframes in the signal.

Note that a complete set of results for the control channels is available only under certain circumstances.

- The corresponding control channel has to be present and enabled (see chapter 5.3.6, "Configuring the Control Channels", on page 100).
- Each channel must have a certain configuration (see list below).

For each channel, the table shows a different set of values.
- PBCH
  For the PBCH, the Channel Decoder provides the following results.

– the MIMO configuration of the DUT (1, 2 or 4 TX antennas)
– the Transmission bandwidth
– the Duration of the PHICH (normal or extended)
– the PHICH resource which is the same as PHICH N_g (1/6, 1/2, 1 or 2)
– System frame number

If the CRC is not valid, a corresponding message is shown instead of the results. Results for the PBCH can only be determined if the PHICH Duration or the PHICH N_g are automatically determined ("Auto") or if automatic decoding of all control channels is turned on.

- PCFICH
  For the PCFICH, the Channel Decoder provides the number of OFDM symbols that are used for PDCCH at the beginning of a subframe.

- PHICH
  The PHICH carries the hybrid-ARQ ACK/NACK. Multiple PHICHs mapped to the same set of resource elements are a PHICH group. The PHICHs within one group are separated by different orthogonal sequences.
  For the PHICH, the Channel Decoder provides the ACK/NACK pattern for the PHICH group and the relative power for each PHICH in the PHICH group. Each line in the result table represents one PHICH group. The columns on the left show the ACK/NACK pattern of the PHICH group. The columns on the right show the relative powers for each PHICH.
  If a PHICH is not transmitted, the table contains a "-" sign. Otherwise, the ACK/NACK pattern is either a "1" (acknowledgement) or a "0" (not acknowledged). The relative power is a numeric value in dB.

- PDCCH
  For each PDCCH that has been detected, the Channel Decoder shows several results. Each line in the table represents one PDCCH.
  – RNTI
  – DCI Format
    Shows the Downlink Control Information (DCI) format. The DCI contains information about the resource assignment for the UEs.
    The following DCI formats are supported: 0, 1, 1A, 1B, 1C, 2, 2A, 2C, 3, 3A.
    The DCI format is determined by the length of the DCI. Because they have the same length, the Channel Decoder is not able to distinguish formats 0, 3 and 3A. Note that a DCI that consist of only zero bits cannot be decoded.
  – PDCCH format used to transmit the DCI
  – CCE Offset
    The CCE Offset represents the position of the current DCI in the PDCCH bit stream.

  Results for the PDCCH can only be determined if the PDSCH subframe configuration is detected by the "PDCCH Protocol" or if automatic decoding of all control channels is turned on.

- PDSCH
  For each decoded PDSCH allocation there is a PDCCH DCI. The DCI contains parameters that are required for the decoding process. If the channel could be decoded successfully, the result display shows the bit stream for each codeword.
  If the Cyclic Redundancy Check (CRC) fails, the result display shows an error message instead.

Results for the PDSCH can only be determined if the PDSCH subframe configuration is detected by the "PDCCH Protocol" or if automatic decoding of all control channels is turned on.

Remote command:
CALCulate<screenid>:FEED 'STAT:CDR'
TRACe:DATA?

3.7 Measuring Beamforming

This chapter contains information on all measurements that show the quality of the beamforming.

UE Specific RS Weights (Magnitude)
Starts the UE-Specific RS Weights Magnitude result display.

This measurement shows the magnitude of the measured weights of the reference signal (RS) carriers specific to the user equipment (UE). This measurement can be used to calculate the relative magnitude difference between different antenna ports. You can select the antenna port to be measured via the Beamforming Selection softkey.

Note that you can only make an antenna port selection if the UE-specific RS weights magnitude measurement is selected.

The measurement is evaluated over the currently selected subframe. The currently selected subframe depends on your selection. Note that this measurement is not available if the subframe selection is set to all.

The x-axis represents the frequency. On the y-axis, the weights magnitude is plotted in dB.
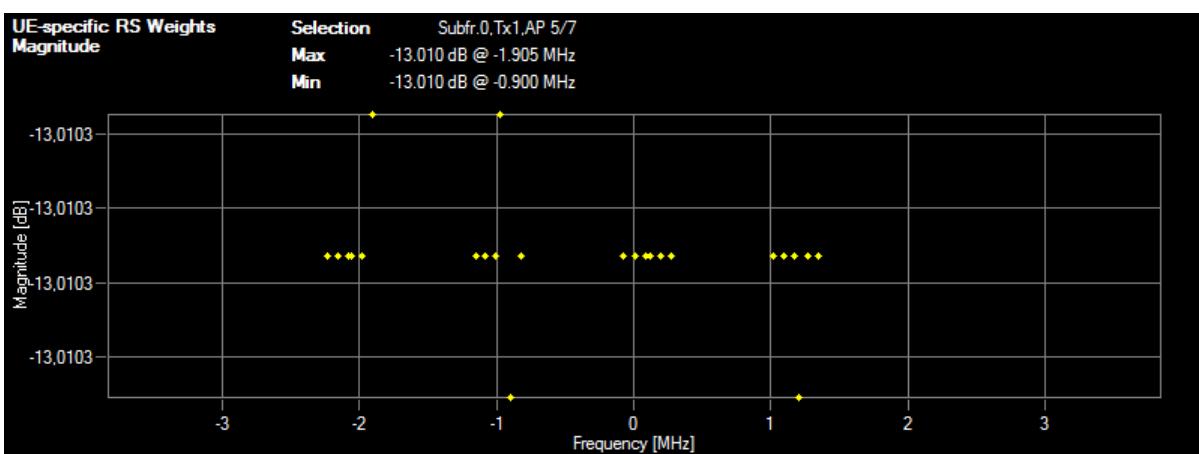
Remote command:
CALCulate<screenid>:FEED 'BEAM:URWM'
TRACe:DATA?

UE Specific RS Weights (Phase)

Starts the UE-specific RS Weights Phase result display.

This measurement shows the phase of the measured weights of the reference signal (RS) carriers specific to the user equipment (UE). This measurement can be used to calculate the relative phase difference between different antenna ports. You can select the antenna port to be measured via the Beamforming Selection softkey.

Note that you can only make an antenna port selection if the UE-specific RS meights phase measurement is selected.

The measurement is evaluated over the currently selected subframe. The currently selected subframe depends on your selection. Note that this measurement is not available if the subframe selection is set to all.

The x-axis represents the frequency. On the y-axis, the weights phase is plotted in degree.
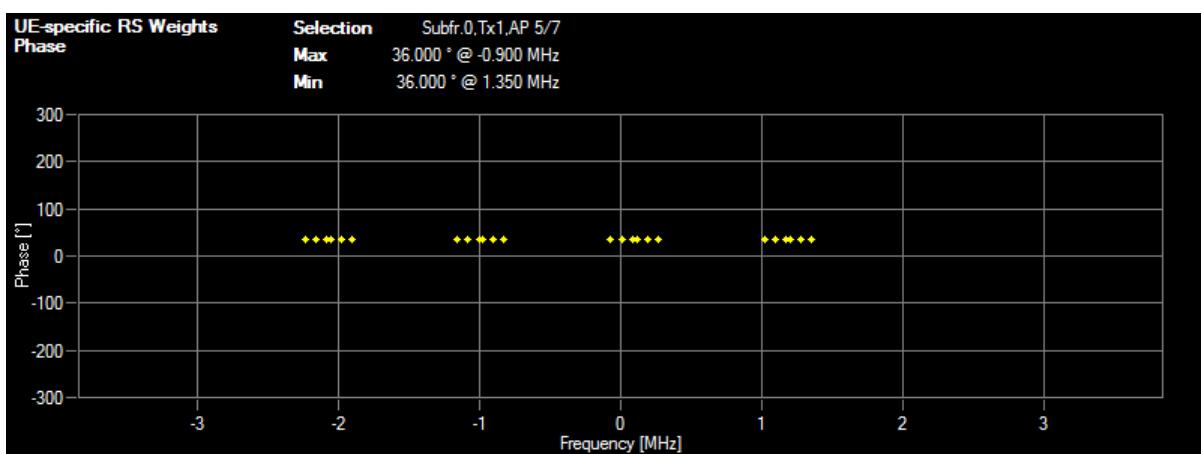
Remote command:
CALCulate<screenid>:FEED 'BEAM:URWP'
TRACe:DATA?

Beamforming Selection

Filters the displayed results to include only certain antenna port(s).

The availability of antenna ports depends on the number of transmission antennas and the number of beamforming layers you are testing.

Remote command:
CONFigure[:LTE]:DL:BF:AP on page 133

4 General Settings

The following chapter contains all settings that are available in the "General Settings" dialog box.

4.1 Configuring the Measurement

The general settings contain various settings that configure the general measurement setup.

You can find the signal characteristics in the "General Settings" dialog box.

4.1.1 Defining General Signal Characteristics

The general signal characteristics contain settings to describe the general physical attributes of the signal.

The signal characteristics are part of the "General Settings" tab of the "General Settings" dialog box.
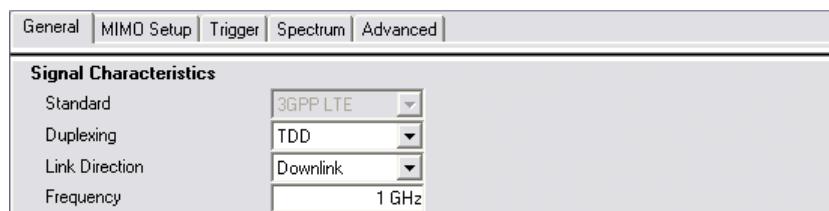
Selecting the LTE Mode
The LTE mode is a combination of the "Standard" (always 3GPP LTE), the "Duplexing" mode and the "Link Direction".

The choices you have depend on the set of options you have installed.

- option FSx-K100(PC) enables testing of 3GPP LTE FDD signals on the downlink
- option FSx-K101(PC) enables testing of 3GPP LTE FDD signals on the uplink
- option FSx-K102(PC) enables testing of 3GPP LTE MIMO signals on the downlink
- option FSx-K103(PC) enables testing of 3GPP MIMO signals on the uplink
- option FSx-K104(PC) enables testing of 3GPP LTE TDD signals on the downlink
- option FSx-K105(PC) enables testing of 3GPP LTE TDD signals on the uplink

FDD and TDD are **duplexing** methods.
- FDD mode uses different frequencies for the uplink and the downlink.
- TDD mode uses the same frequency for the uplink and the downlink.

Downlink (DL) and Uplink (UL) describe the **transmission path**.
- Downlink is the transmission path from the base station to the user equipment. The physical layer mode for the downlink is always OFDMA.
- Uplink is the transmission path from the user equipment to the base station. The physical layer mode for the uplink is always SC-FDMA.

The software shows the currently selected LTE mode (including the bandwidth) in the header table.

Freq	1 GHz	CP/Cell ID	E
Mode	**UL TDD, 10 MHz**	Sync State	--

Remote command:
CONFigure[:LTE]:LDIRection on page 164
CONFigure[:LTE]:DUPLexing on page 163

Defining the Signal Frequency
For measurements with an RF input source, you have to match the **center frequency** of the analyzer to the frequency of the signal.

The software shows the current center frequency in the header table.

Freq	**1 GHz**	CP/Cell ID	E
Mode	UL TDD, 10 MHz	Sync State	--

The available frequency range depends on the hardware configuration of the analyzer you are using.

Remote command:
Center frequency:
[SENSe]:FREQuency:CENTer[:CC<cci>] on page 164

4.1.2 Configuring the Input

The input settings control the basic configuration of the input.

The input source selection is part of the "General Settings" tab of the "General Settings" dialog box.

For more information on advanced input configuration see chapter 4.5, "Advanced Settings", on page 76.

Selecting the Input Source
The input source selects the source of the data you'd like to analyze. You can either analyze a live signal or a signal that has been recorded previously and whose characteristics have been saved to a file.

You can select the input source from the "Source" dropdown menu.

● RF
Captures and analyzes the data from the RF input of the spectrum analyzer in use.
● Baseband (BB)
Captures and analyzes the data from the baseband input of the spectrum analyzer in use.
Note that you have to use an analyzer that supports analog baseband input if you select that input source.
● Digital I/Q
Captures and analyzes the data from the digital baseband input of the spectrum analyzer in use.
Note that you have to use an analyzer that supports digital baseband input if you select that input source.
● File
Analyzes data that has been recorded already and has been saved to a file.
If selected, the software asks you to select a file from a dialog box after you have initiated a measurement. If the file contents are not valid or the file could not be found, the software shows an error message.
A connection to an analyzer or a dongle is required to successfully load a file.
For more information see chapter 7.1, "Importing and Exporting I/Q Data", on page 108.

Remote command:
SENSe:INPut on page 164

4.1.3 Configuring the Input Level

The level settings contain settings that control the input level of any analyzer in the measurement setup.

You can control the input level for any of the input channels you are using separately from the dropdown menu next to the "Level Settings" label.

The level settings are part of the "General Settings" tab of the "General Settings" dialog box.
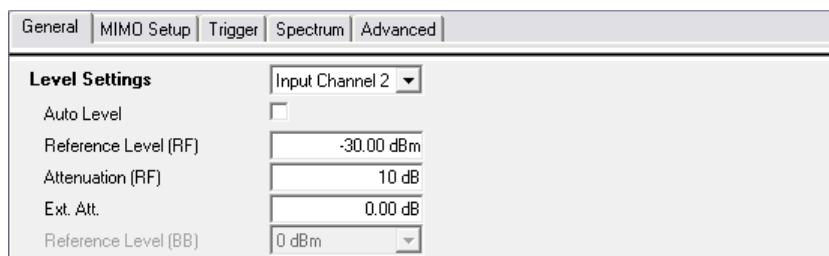
Defining a Reference Level

The reference level is the power level the analyzer expects at the RF input. Keep in mind that the power level at the RF input is the peak envelope power in case of signals with a high crest factor like LTE.

To get the best dynamic range, you have to set the reference level as low as possible. At the same time, make sure that the maximum signal level does not exceed the reference level. If it does, it will overload the A/D converter, regardless of the signal power. Measurement results may deteriorate (e.g. EVM). This applies especially for measurements with more than one active channel near the one you are trying to measure (± 6 MHz).

Note that the signal level at the A/D converter may be stronger than the level the application displays, depending on the current resolution bandwidth. This is because the resolution bandwidths are implemented digitally after the A/D converter.

You can either specify the **RF Reference Level** (in dBm) or **Baseband Reference Level** (in V), depending on the input source.

You can also use **automatic detection** of the reference level with the "Auto Level" function.

If active, the software measures and sets the reference level to its ideal value before each sweep. This process slightly increases the measurement time. You can define the measurement time of that measurement with the **Auto Level Track Time** (➜ "Advanced" tab).

Automatic level detection also optimizes RF attenuation.

Automatic level detection is available for an RF input source.

The software shows the current reference level of the first input channel (including RF and external attenuation) in the header table.

Remote command:
Manual (RF):
CONFigure:POWer:EXPected:RF<analyzer> on page 165
Manual (BB):
CONFigure:POWer:EXPected:IQ<analyzer> on page 166
Automatic:
[SENSe]:POWer:AUTO<analyzer>[:STATe] on page 165
Auto Level Track Time:
[SENSe]:POWer:AUTO<analyzer>:TIME on page 178

Attenuating the Signal

Attenuation of the signal may become necessary if you have to reduce the power of the signal that you have applied. Power reduction is necessary, for example, to prevent an overload of the input mixer.

You can attenuate the signal at the RF input of one of the analyzers in the measurement setup (mechanical or **RF attenuation**) or attenuate the signal externally (**external attenuation**).

If you attenuate or amplify the signal either way, the software adjusts the numeric and graphical results accordingly. In case of graphical power result displays, it moves the trace(s) vertically by the specified value.

Positive values correspond to an attenuation and negative values correspond to an amplification.

The range of the RF attenuation depends on the hardware you are using in the measurement setup. For details refer to its data sheet. If the attenuation you have set is not supported by the hardware, the software corrects the attenuation and shows a corresponding message.

The software shows the RF and external attenuation level in the header table next to the reference level.

Remote command:
RF attenuation:
INPut<n>:ATTenuation<analyzer> on page 166
External attenuation:
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet on page 166

4.1.4 Configuring the Data Capture

The data capture settings contain settings that control the amount of data and the way that the software records the LTE signal.

The data capture settings are part of the "General Settings" tab of the "General Settings" dialog box.

Capture Time

Defines the capture time.

The capture time corresponds to the time of one sweep. Hence, it defines the amount of data the software captures during one sweep.

By default, the software captures 20.1 ms of data to make sure that at least one complete LTE frame is captured in one sweep.

The software shows the current capture time (including the frame number) in the header table.

Remote command:
[SENSe]:SWEep:TIME on page 166

Overall Frame Count

Turns the manual selection of the number of frames to capture (and analyze) on and off.

If the overall frame count is active, you can define a particular number of frames to capture and analyze. The measurement runs until all required frames have been analyzed, even if it takes more than one sweep. The results are an average of the captured frames.

If the overall frame count is inactive, the software analyzes all complete LTE frames currently in the capture buffer.

Remote command:
[SENSe][:LTE]:FRAMe:COUNt:STATe on page 167

Number of Frames to Analyze

Sets the number of frames that you want to capture and analyze.

If the number of frames you have set last longer than a single sweep, the software continues the measurement until all frames have been captured.

The parameter is read only if

● the overall frame count is inactive,
● the data is captured according to the standard.

Remote command:
[SENSe][:LTE]:FRAMe:COUNt on page 167

Auto According to Standard

Turns automatic selection of the number of frames to capture and analyze on and off.

If active, the software evaluates the number of frames as defined for EVM tests in the LTE standard.

If inactive, you can set the number of frames you want to analyze.

This parameter is not available if the overall frame count is inactive.

Remote command:
[SENSe][:LTE]:FRAMe:COUNt:AUTO on page 167

4.1.5 Configuring Measurement Results

The measurement result settings contain settings that define certain aspects of the results that are displayed.

The result settings are part of the "General Settings" tab of the "General Settings" dialog box.
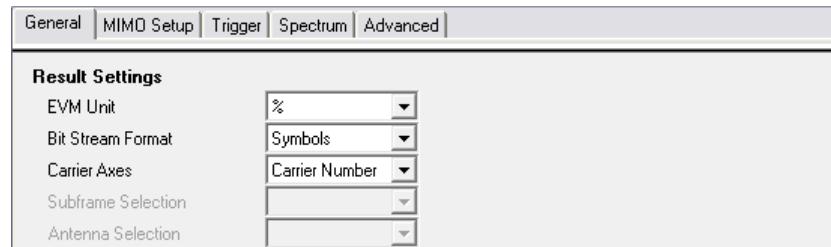
EVM Unit
Selects the unit for graphic and numerical EVM measurement results.

Possible units are dB and %.

Remote command:
UNIT:EVM on page 168

Bit Stream Format
Selects the way the bit stream is displayed.

The bit stream is either a stream of raw bits or of symbols. In case of the symbol format, the bits that belong to a symbol are shown as hexadecimal numbers with two digits.

Examples:

Fig. 4-1: Bit stream display in downlink application if the bit stream format is set to "symbols"

B Bit Stream	Subframe(s)	ALL			
Sub-frame	Allocation ID	Code-word	Modulation	Bit Index	Bit Stream
0	PBCH	1/1	QPSK	0	100000000010000100011000010011100101010100001101
0	PBCH	1/1	QPSK	48	111010011011100100001010000101011010011111011001
0	PBCH	1/1	QPSK	96	001001011011111100100110101001100110000000110001
0	PBCH	1/1	QPSK	144	100101000110100101111111010001011000111010110010

Fig. 4-2: Bit stream display in downlink application if the bit stream format is set to "bits"

Remote command:
UNIT:BSTR on page 168

Carrier Axes

Selects the scale of the x-axis for result displays that show results of OFDM subcarriers.

- X-axis shows the frequency of the subcarrier
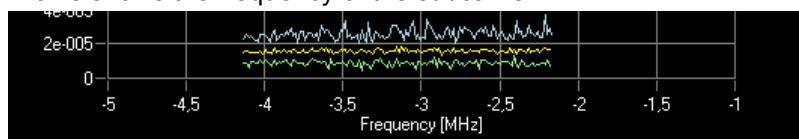
- X-axis shows the number of the subcarrier

Remote command:
UNIT:CAXes on page 168

Subframe Selection

Selects a particular subframe whose results the software displays.

You can select a particular subframe for the following measurements.

Result Summary, EVM vs. Carrier, EVM vs. Symbol, Channel Flatness, Channel Group Delay, Channel Flatness Difference, Constellation Diagram, Allocation Summary and Bit Stream. If ---All--- is selected, either the results from all subframes are displayed at once or a statistic is calculated over all analyzed subframes.

Selecting "All" either displays the results over all subframes or calculates a statistic over all subframes that have been analyzed.

Example: Subframe selection

If you select all subframes ("All"), the software shows three traces. One trace shows the subframe with the minimum level characteristics, the second trace shows the subframe with the maximum level characteristics and the third subframe shows the averaged level characteristics of all subframes.

- PK: peak value
- AV: average value
- MI: minimum value

If you select a specific subframe, the software shows one trace. This trace contains the results for that subframe only.

Remote command:
[SENSe][:LTE]:SUBFrame:SELect on page 169

Antenna Selection
Selects the antenna you want to display the results for.

For more information see "MIMO Configuration" on page 72.

Remote command:
[SENSe][:LTE]:ANTenna:SELect on page 168
[SENSe][:LTE]:SOURce:SELect on page 169

4.1.6 Configuring Time Alignment Measurements

The Time Alignment measurement settings contain settings that define certain aspects of this measurement.

The Time Alignment measurement settings are part of the "General Settings" tab of the "General Settings" dialog box.
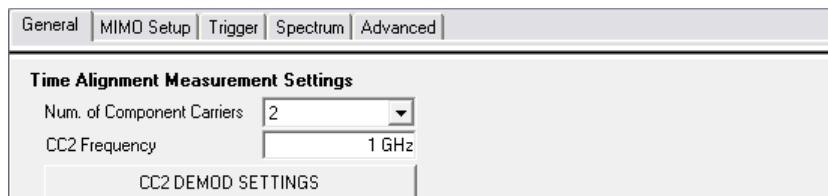
Carrier Aggregation..70

Carrier Aggregation

The software supports Time Alignment Error measurements with carrier aggregation.

Select the number of carriers from the **"Number of Component Carriers"** dropdown menu.

If you select more than one carrier, define the frequency of the other in carrier in the **"CC2 Frequency"** field.

The **"CC2 Demod Settings"** button opens a dialog box to configure the signal characteristics of the second carrier. This dialog contains a selection of the demodulation settings. For more information see chapter 5, "Demod Settings", on page 81.

Note that the software shows measurement results for the second component carrier even if only one antenna of the second component carrier is attached (i.e. no combiner used).

Remote command:
CONFigure:NOCC on page 170

[SENSe]:FREQuency:CENTer[:CC<cci>] on page 164

CC2 Demod settings:
See chapter 9.8, "Remote Command to Configure the Demodulation", on page 179

4.1.7 Configuring Transmit On/Off Power Measurements

The On/Off Power measurement settings contain settings that define certain aspects of those measurements.

The On/Off Power measurement settings are part of the "General Settings" tab of the "General Settings" dialog box.

Number of Frames

Defines the number of frames that are averaged to calculate a reliable power trace for On/Off Power measurements.

Remote command:
CONFigure[:LTE]:OOPower:NFRames on page 171

Noise Correction

Turns noise correction for On/Off Power measurements on and off.

For more information see the manual of the software.

Remote command:
[SENSe][:LTE]:OOPower:NCORrection on page 171

Carrier Aggregation
The software supports Transmit On/Off Power measurements with carrier aggregation.

To turn on measurements on more than one carrier, check the **"Carrier Aggregation"** parmeter. If on, the **"Frequency Lower Edge"** and **"Frequency Higher Edge"** field become available.

When defining the lower and higher frequency, make sure to that the values are valid.

● The center frequency of the master component carrier (➜ Defining the Signal Frequency) has to be within the bandwidth defined by the lower and higher edge frequencies.
● The bandwidth defined by the lower and higher edge frequencies must not be too large.

If one of these conditions is not met, the fields turn red or the software shows an error message.

Remote command:
[SENSe][:LTE]:OOPower:CAGGregation on page 170
[SENSe][:LTE]:OOPower:FREQuency:LOWer on page 171
[SENSe][:LTE]:OOPower:FREQuency:HIGHer on page 170

4.2 Configuring MIMO Measurement Setups

The MIMO settings contain settings to configure a MIMO test setup and control the instruments in that test setup.

The MIMO settings are part of the "Analyzer Config / MIMO Setup" tab of the "General Settings" dialog box.
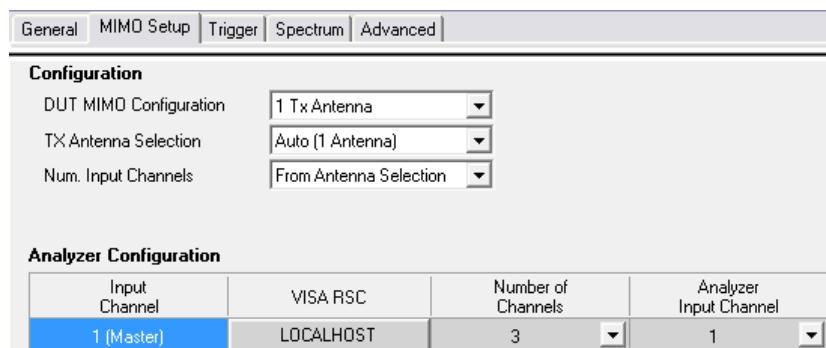
MIMO Configuration

The software supports measurements on DUTs with up to 8 antennas and is thus able to capture up to 8 I/Q data streams. You can select the number of antennas that transmit cell-specific reference signals (antenna ports AP 0 to 3) from the **"DUT MIMO Configuration"** dropdown menu.

The **"Tx Antenna Selection"** dropdown menu selects a particular antenna for evaluation. The number of items depends on the number of antennas you have selected in the "DUT MIMO Configuration" dropdown menu.

- "Antenna 1" corresponds to AP0
- "Antenna 2" corresponds to AP1
- "Antenna 3" corresponds to AP2
- "Antenna 4" corresponds to AP3
- If you select the "Auto" menu item, the software identifies which antennas transmit the cell-specific reference signals and selects them for the measurement.

The antenna you have selected is also the reference antenna for Time Alignment measurements.

Note that the "DUT MIMO Configuration" and the "Tx Antenna Selection" are the same as in the "Downlink Signal Characteristics" tab (➜ "Demod Settings") - if you change them in one place, they are also changed in the other.

For more information on MIMO measurements see chapter 8.4, "MIMO Measurement Guide", on page 116.

The **"Num of Input Channels"** defines the number of I/Q streams to capture. The software allows you to record up to 8 I/Q data streams. You can capture the data from oscilloscope(s) or spectrum analyzer(s), or a combination of both. Depending on the number of input channels you have selected, the software adjusts the size of the **"Analyzer Configuration"** table.

Note: Time Alignment measurements with more than one carrier (➜ Carrier Aggregation) also expand the size of the table, because more than one analyzer is necessary for this task.

The number of input channels you have selected also affects the contents of the **"Antenna Selection"** dropdown menu (➜ "General Settings" tab). A description is provided below ("Antenna (Port) Selection").

Selecting the "From Antenna Selection" menu item has the following effects.
- The number of used input channels depends on the number of antennas (➜ "MIMO Configuration") and the "Tx Antenna Selection".
- The contents of the "Tx Antenna Selection" dropdown menu change. In addition to selecting a particular antenna, you can let the software decide which antenna(s) to test and in which order (➜ "Auto 1 Antenna" etc.).
  In case of automatic detection the software analyzes the reference signal(s) to select the antenna(s).

Displayed results for MIMO measurements

In the default state, each active result display shows the result for each input channel. Thus, the number of results corresponds to the **"Number of Input Channels"** you have selected. For example, if you have selected 4 input channels, the software would show 4 Constellation Diagrams.

Because this screen layout may make it difficult to read individual results, you have several options to increase the comfort of evaluating the results.

- Display one result display only (➔ Full screen mode)
- Open each result display in a separate window (➔ "Open in Separate Window")
- Display the results for a particular stream of I/Q data only (➔ Antenna Selection, ➔ "General" tab)
  Note that a particular I/Q data stream may still contain information on several antenna ports.

Antenna (Port) Selection

In the Antenna Selection dropdown menu (➔ "General" tab), the software allows you to select the antenna ports whose results are shown. Antenna port selection is possible only after the I/Q data has been already captured.

The contents of the dropdown menu depend on several parameters.

- the MIMO configuration (1, 2 or 4 antenna)
- the antenna selected for analysis
- the number of input channels
- the state of the CSI reference signal
- the state of the positioning reference signal

The mapping of antenna ports to antenna is done by the software. Antennas that transmit a cell-specific reference signal (AP0 - AP3) are labeled "Tx1" to "Tx4". All other antennas are labeled "Tx BF" (beamforming).

Each menu item covers one or more antenna ports. The antenna ports are added and removed by the following rules.

- Antenna Port 0 - 3 (AP0 - AP3)
  Available for analysis of antennas 1 to 4.
- Antenna Port 4 (AP4)
  Analysis currently not supported.
- Antenna Port 6 (AP6)
  Available for analysis if the Positioning Reference Signal is present.
- Antenna Port 7 - 14 (AP7 - AP14)
  Available for analysis of UE-specific references.
- Antenna Port 15 - 22 (AP15 - AP22)
  Available for analysis if the CSI Reference Signal is present.

Remote command:
DUT MIMO configuration:
CONFigure[:LTE]:DL[:CC<cci>]:MIMO:CONFig on page 187
TX antenna selection:
CONFigure[:LTE]:DL[:CC<cci>]:MIMO:ASELection on page 187
Number of input channels:
CONFigure[:LTE]:NSOurces on page 172
I/Q data stream selection:
[SENSe][:LTE]:SOURce:SELect on page 169

MIMO Analyzer Configuration
For a comprehensive description see chapter 2.3, "Connecting the Computer to an Analyzer", on page 19.

4.3 Triggering Measurements

The trigger settings contain settings that control triggered measurements.

You can select a trigger for any of the four possible analyzers in the measurement setup separately by selecting one of the analyzers from the dropdown menu next to the "Trigger Settings" label.

The trigger settings are part of the "General Settings" tab of the "General Settings" dialog box.
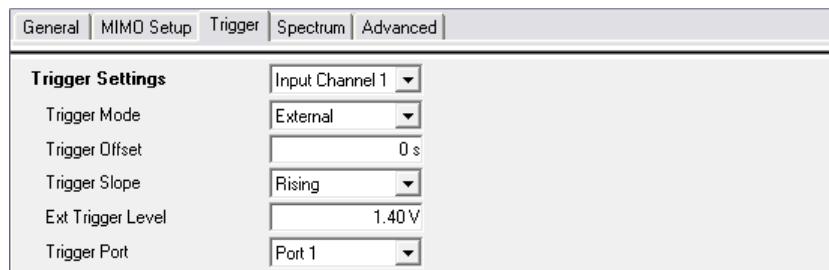
Configuring the Trigger
A trigger allows you to capture those parts of the signal that you are really interested in.

While the software runs freely and analyzes all signal data in its default state, no matter if the signal contains information or not, a trigger initiates a measurement only under certain circumstances (the trigger event).

The software supports several **trigger modes** or sources.

- Free Run
  Starts the measurement immediately and measures continuously.
- External
  The trigger event is the level of an external trigger signal. The measurement starts when this signal meets or exceeds a specified trigger level at the "Ext Trigger/Gate" input.
  Some measurement devices have several trigger ports. When you use one of these, you can additionally select the **trigger port** (1 to 3) you want to use.
- IF Power
  The trigger event is the IF power level. The measurement starts when the IF power meets or exceeds a specified power trigger level.
- Trigger Unit FS-Z11
  The R&S FS-Z11 is a trigger unit designed to control triggers in MIMO measurement setups.
  Note that the trigger unit is not compatible with oscilloscope measurements.
  For more information see chapter 8.4.1.2, "Performing MIMO Measurements with a Trigger Unit", on page 119 and the documentation of the R&S FS-Z11.

You can define a **power level** for an external and an IF power trigger.

For most trigger sources you can select the **trigger slope**. The trigger slope defines whether triggering occurs when the signal rises to the trigger level or falls down to it.

The measurement starts as soon as the trigger event happens. It may become necessary to start the measurement some time after the trigger event. In that case, define a **trigger offset** (or trigger delay). The trigger offset is the time that should pass between the trigger event and the start of the measurement.

The trigger offset may be a negative time. The trigger offset is then called a **pretrigger**.

The trigger offset is available for all trigger modes, except free run.

Remote command:
For a comprehensive list of commands to define trigger characteristics see chapter 9.7.3, "Using a Trigger", on page 173.

4.4   Spectrum Settings

The spectrum settings contain settings to configure frequency sweep measurements (ACLR and SEM).

You can find the spectrum settings in the "General Settings" dialog box.

4.4.1   Configuring SEM and ACLR Measurements

The SEM (Spectrum Emission Mask) and ACLR (Adjacent Channel Leakage Ratio) settings contain settings that define aspects of those measurements.

The SEM and ACLR settings are part of the "General Settings" tab of the "General Settings" dialog box.
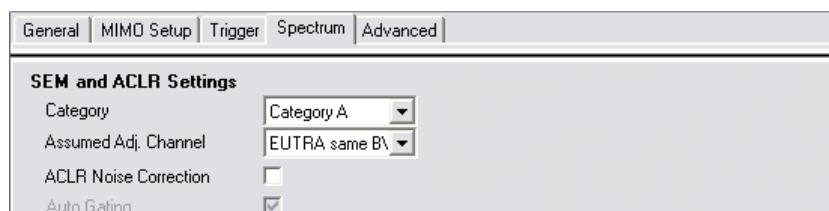
Category
Selects the type, category and option of the limit defintions for SEM measurements.

The software supports limit defintions for the following types of base stations:
- Wide areas base stations (Category A and B)
- Local Area base stations
- Home base stations

Category A and B are defined in ITU-R recommendation SM.329. For Category B operating band unwanted emissions, there are two options for the limits that may be applied regionally (Opt1 and Opt2).

The type and category you should use for the measurement depends on the category and option that the base station you are testing supports.

For Home Area base stations, you can define an additional "Aggregated Max Power" for all antenna ports of a home area base station. The aggregated maximum power is the aggregated power of all antenna ports and has an effect on the shape of the SEM.

Remote command:

[SENSe]:POWer:SEM:CATegory on page 175

Assumed Adjacent Channel Carrier

Selects the assumed adjacent channel carrier for the ACLR measurement.

The supported types are EUTRA of same bandwidth, 1.28 Mcps UTRA, 3.84 Mcps UTRA and 7.68 Mcps UTRA.

Note that not all combinations of LTE Channel Bandwidth settings and Assumed Adj. Channel Carrier settings are defined in the 3GPP standard.

Remote command:

[SENSe]:POWer:ACHannel:AACHannel on page 175

Noise Correction

Turns noise correction on and off.

For more information see the manual of the software.

Note that the input attenuator makes a clicking noise after each sweep if you are using the noise correction in combination with the auto leveling process.

Remote command:

[SENSe]:POWer:NCORrection on page 176

Auto Gating

Turns gating for SEM and ACLR measurements on and off.

If on, the software evaluates the on-periods of an LTE TDD signal only. The software determines the location and length of the on-period from the "TDD UL/DL Allocations" and the "Configuration of the Special Subframe".

Auto gating is available for TDD measurements in combination with an external or IF power trigger.

If you are using an external trigger, the DUT has to send an LTE frame trigger.

Remote command:

[SENSe]:SWEep:EGATe:AUTO on page 176

4.5 Advanced Settings

The advanced settings contain settings to configure the signal input and some global measurement analysis settings.

You can find the advanced settings in the "General Settings" dialog box.

4.5.1 Controlling I/Q Data

The I/Q settings contain settings that control the I/Q data flow.

The I/Q settings are part of the "Advanced Settings" tab of the "General Settings" dialog box.
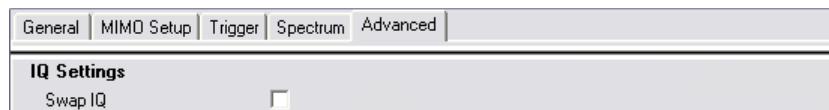
Swap I/Q
Swaps the real (I branch) and the imaginary (Q branch) parts of the signal.

Remote command:
[SENSe]:SWAPiq on page 176

4.5.2 Configuring the Baseband Input

The baseband settings contain settings that configure the baseband input.

The baseband settings are part of the "Advanced Settings" tab of the "General Settings" dialog box.

High Impedance
Selects the impedance of the baseband input.

By default (high impedance is off), the impedance is 50 Ω.

If you turn the high impedance on, the impedance changes to 1 kΩ or 1 MΩ, depending on the configuration of the analyzer.

High impedance is available for a baseband input source.

Remote command:
INPut:IQ:IMPedance on page 177

Balanced
Turns symmetric (or balanced) input on and off.

If active, a ground connection is not necessary. If you are using an assymetrical (unbalanced) setup, the ground connection runs through the shield of the coaxial cable that is used to connect the DUT

Balancing is available for a baseband input source.

Remote command:
INPut:IQ:BALanced[:STATe] on page 177

Low Pass
Turns an anti-aliasing low pass filter on and off.

The filter has a cut-off frequency of 36 MHz and prevents frequencies above from being mixed into the usable frequency range. Note that if you turn the filter off, harmonics or spurious emissions of the DUT might be in the frequency range above 36 MHz and might be missed.

You can turn it off for measurement bandwidths greater than 30 MHz.

The low pass filter is available for a baseband input source.

Remote command:
[SENSe]:IQ:LPASs[:STATe] on page 177

Dither
Adds a noise signal into the signal path of the baseband input.

Dithering improves the linearity of the A/D converter at low signal levels or low modulation. Improving the linearity also improves the accuracy of the displayed signal levels.

The signal has a bandwidth of 2 MHz with a center frequency of 38.93 MHz.

Dithering is available for a baseband input source.

Remote command:
[SENSe]:IQ:DITHer[:STATe] on page 177

4.5.3   Using Advanced Input Settings

The advanced input settings contain settings that configure the RF input.

The advanced input settings are part of the "Advanced Settings" tab of the "General Settings" dialog box.
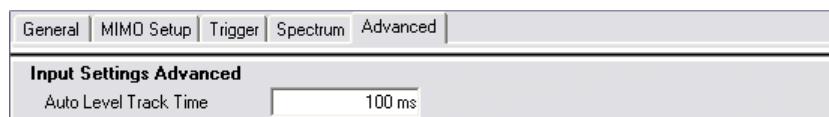
For more information see "Defining a Reference Level" on page 64.

4.5.4   Configuring the Digital I/Q Input

The digital I/Q settings contain settings that configure the digital I/Q input.

The digital I/Q settings are part of the "Advanced Settings" tab of the "General Settings" dialog box.
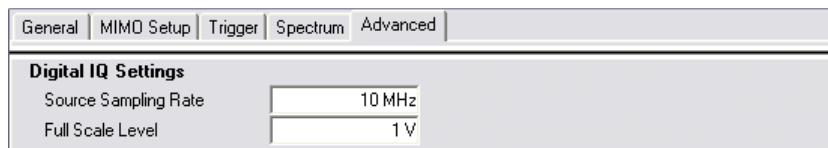
Sampling Rate (Input Data Rate)
Defines the data sample rate at the digital baseband input.

The sample rate is available for a digital baseband input source.

Remote command:
INPut<n>:DIQ:SRATe on page 178

Full Scale Level
Defines the voltage corresponding to the maximum input value of the digital baseband input.

Remote command:
INPut<n>:DIQ:RANGe[:UPPer] on page 178

4.5.5 Configuring Home Base Station Tests

The home base station settings contain settings that configure spectrum emission mask measurements for home base stations.

The SEM category Home BS settings are part of the "Advanced Settings" tab of the "General Settings" dialog box.

Aggregated Maximum Power Of All TX Ports (P)
Defines the aggregated maximum power of all TX ports of home base stations. The aggregate maximum power is required to calculate limit line values for SEM measurements on home base stations.

The parameter is available only if you have selected SEM Category "Home".

Remote command:
[SENSe]:POWer:SEM:CHBS:AMPower on page 179

4.5.6 Global Settings

The global settings contain settings that are independent of other settings.

The global settings are part of the "Advanced Settings" tab of the "General Settings" dialog box.

| General | MIMO Setup | Trigger | Spectrum | Advanced |

Global Settings
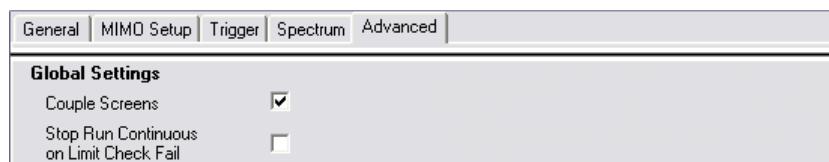
Couple Screens ☑

Stop Run Continuous
on Limit Check Fail ☐

Couple Screens

Couples and decouples markers that have the same x-axis unit in the top and bottom result displays (e.g. both result displays have a frequency axis).

In case of the constellation diagram, the constellation selection is also coupled to the marker.

Stop Run Continuous On Limit Check Fail

Stops a continuous measurement if the signal fails any limit check in the currently active result display.

For example, the measurement would stop on an EVM PDSCH QPSK limit check fail if the result summary is active.

5 Demod Settings

The following chapter contains all settings that are available in the "Demodulation Settings" dialog box.

5.1 Configuring Downlink Signal Demodulation

The downlink demodulation settings contain settings that describe the signal processing and the way the signal is measured.

You can find the demodulation settings in the "Demod Settings" dialog box.

5.1.1 Selecting the Demodulation Method

The PDSCH demodulation settings contain settings that describe the way the PDSCH is demodulated during measurements.

The demodulation settings are part of the "Downlink Demodulation Settings" tab of the "Demodulation Settings" dialog box.

Auto PDSCH Demodulation
Turns automatic demodulation of the PDSCH on and off.

Turn on automatic PDSCH demodulation for automatic detection of the PDSCH resource allocation. The software is able to detect the PDSCH resource allocation by analyzing the protocol information in the PDCCH or by analyzing the physical signal. It then writes the results into the PDSCH Configuration Table.

You can set the way the software identifies the PDSCH resource allocation with "PDSCH Subframe Configuration Detection" on page 82.

If the automatic demodulation of the PDSCH is off, you have to configure the PDSCH manually. In that case, the software compares the demodulated LTE frame to the customized configuration. If the PDSCH Subframe Configuration Detection is not turned off, the software analyzes the frame only if both configurations are the same.

Remote command:

[SENSe][:LTE]:DL:DEMod:AUTO on page 180

PDSCH Subframe Configuration Detection

Selects the method of identifying the PDSCH resource allocation.

- Off
  Uses the user configuration to demodulate the PDSCH subframe. If the user configuration does not match the frame that was measured, a bad EVM will result.
- PDCCH protocol
  Sets the PDSCH configuration according to the data in the protocol of the PDCCH DCIs.
- Physical detection
  The physical detection is based on power and modulation detection.
  Physical detection makes measurements on TDD E-TMs without a 20 ms trigger signal possible.
  For more information on automatic demodulation see "Auto PDSCH Demodulation" on page 81.

Remote command:

[SENSe][:LTE]:DL:FORMat:PSCD on page 180

5.1.2 Configuring Multicarrier Base Stations

The multicarrier base station settings contain settings to configure measurements on multicarrier base stations.

The multicarrier base station settings are part of the "Downlink Demodulation Settings" tab of the "Demodulation Settings" dialog box.

| Downlink Demodulation Settings | Downlink Signal Characteristics | Downlink Advanced Signal Characteristics |

Multicarrier Base Station

Multicarrier Filter   ☐

Multicarrier Filter...82

Multicarrier Filter

Turns the suppression of interference of neighboring carriers for tests on multiradio base stations on and off (e.g. LTE, WCDMA, GSM etc).

Remote command:

[SENSe][:LTE]:DL:DEMod:MCFilter on page 180

5.1.3 Configuring Parameter Estimation

The parameter estimation settings contain settings that estimate various parameters during the measurement.

The parameter estimation settings are part of the "Downlink Demodulation Settings" tab of the "Demodulation Settings" dialog box.

Boosting Estimation
Turns boosting estimation on and off.

If active, the software automatically sets the relative power settings of all physical chan-nels and the P-/S-SYNC by analyzing the signal.

Remote command:
[SENSe][:LTE]:DL:DEMod:BESTimation on page 181

Channel Estimation
Selects the method of channel estimation.

● **EVM 3GPP Definition**
Channel estimation according to 3GPP TS 36.141. This method is based on aver-aging in frequency direction and linear interpolation. Examines the reference signal only.
● **Optimal, Pilot only**
Optimal channel estimation method. Examines the reference signal only.
● **Optimal, Pilot and Payload**
Optimal channel estimation method. Examines both the reference signal and the payload resource elements.

Remote command:
[SENSe][:LTE]:DL:DEMod:CESTimation on page 181

5.1.4 Compensating Signal Errors

The tracking settings contain settings that compensate for various common signal errors that may occur.

The tracking settings are part of the "Downlink Demodulation Settings" tab of the "Demodulation Settings" dialog box.

Phase

Specifies whether or not the measurement results should be compensated for common phase error. When phase compensation is used, the measurement results will be compensated for phase error on a per-symbol basis.

"Off"   Phase tracking is not applied.

"Pilot Only"   Only the reference signal is used for the estimation of the phase error.

"Pilot and Pay-   Both reference signal and payload resource elements are used for the
load"   estimation of the phase error.

Remote command:

[SENSe][:LTE]:DL:TRACking:PHASe on page 181

Timing

Specifies whether or not the measurement results should be compensated for timing error. When timing compensation is used, the measurement results will be compensated for timing error on a per-symbol basis.

Remote command:

[SENSe][:LTE]:DL:TRACking:TIME on page 182

5.1.5 Configuring EVM Measurements

The demodulation EVM settings contain settings that control the way the software calculates EVM results.

The demodulation EVM settings are part of the "Downlink Demodulation Settings" tab of the "Demodulation Settings" dialog box.

EVM Calculation Method

Selects the method to calculate the EVM.

- **EVM 3GPP Definition**
  Calculation of the EVM according to 3GPP TS 36.141. Evaluates the EVM at two trial timing positions and then uses the maximum EVM of the two.
- **At Optimal Timing Position**

Calculates the EVM using the optimal timing position.

Remote command:
[SENSe][:LTE]:DL:DEMod:EVMCalc on page 182

PDSCH Reference Data
Selects the type of reference data to calculate the EVM for the PDSCH.

● Auto detect
  Automatically identifies the reference data for the PDSCH by analyzing the signal.
● All 0 (E-TM)
  Sets the PDSCH reference data to a fixed value of 0. This value is according to the test model definition.
  To get valid results, you have to use a DUT that transmits an all-zero data vector.
  This setting is a good way if you are expecting signals with a high EVM because the automatic detection will not be reliable in that case.

Remote command:
[SENSe][:LTE]:DL:DEMod:PRData on page 182

5.1.6 Processing Demodulated Data

The demodulated data settings contain settings that control the way the software handles demodulated data.

The demodulated data settings are part of the "Downlink Demodulation Settings" tab of the "Demodulation Settings" dialog box.

Scrambling of Coded Bits
Turns the scrambling of coded bits for all physical channels like PDSCH or PHICH on and off.

The scrambling of coded bits affects the bitstream results.
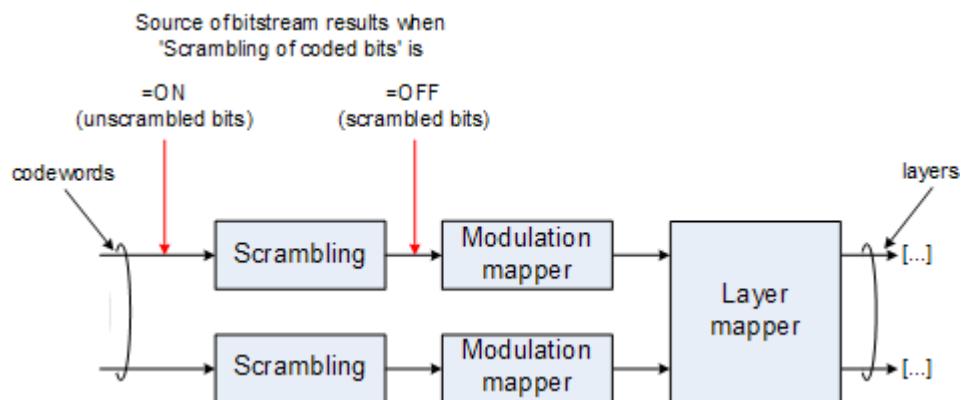
Fig. 5-1: Source for bitstream results if scrambling for coded bits is on and off

Remote command:
[SENSe][:LTE]:DL:DEMod:CBSCrambling on page 183

Decode All Channels

Turns the decoding of all physical channels on and off.

If on, the software shows the decoding results in the "Channel Decoder Results" result display.

If off,

● the PBCH is decoded only if the PHICH Duration or the PHICH N_g are automatically determined
● the PDCCH is decoded only if the PDSCH Subframe Configuration Detection is set to PDCCH protocol.

If decoding of all control channels is off, measurement speed will increase.

Remote command:
[SENSe][:LTE]:DL:DEMod:DACHannels on page 183

5.1.7 Configuring MIMO Setups

The MIMO settings contain settings that configure MIMO measurement setups.

The MIMO settings are part of the "Downlink Demodulation Settings" tab of the "Demodulation Settings" dialog box.
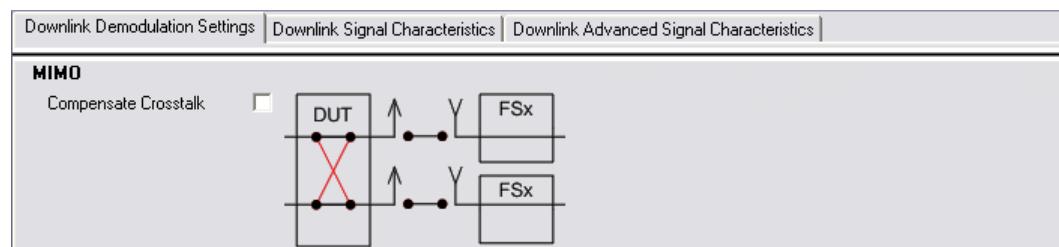
Compensate Crosstalk

Turns compensation of crosstalk produced by one of the components in the test setup on and off.

Turn crosstalk compensation on, if you expect crosstalk from the DUT or another component in the test setup. This may be necessary, for example, for over-the-air measurements.

If you connect the DUT to the analyzer by cable, turn off crosstalk compensation. In that case, the only crosstalk results from the DUT itself and contributes as distortion to the measurement results.

Remote command:
CONFigure[:LTE]:DL:MIMO:CROSstalk on page 183

5.2   Defining Downlink Signal Characteristics

The downlink signal characteristics contain settings to describe the physical attributes and structure of a downlink LTE signal.

You can find the signal characteristics in the "Demod Settings" dialog box.

For more information on the "MIMO Configuration" see "MIMO Configuration" on page 72.

5.2.1   Defining the Physical Signal Characteristics

The physical signal characteristics contain settings to describe the physical attributes of a downlink LTE signal.

The physical settings are part of the "Downlink Signal Characteristics" tab of the "Demodulation Settings" dialog box.

Downlink Demodulation Settings	Downlink Signal Characteristics	Downlink Advanced Signal Characteristics

Physical Settings

Channel Bandwidth	3 MHz (15 RB)	Sampling Rate	3.84 MHz	Occupied BW	2.715 MHz
Cyclic Prefix	Auto	FFT Size	256	Occupied Carriers	181
TDD UL/DL Allocations	Conf. 0	TDD Allocations	DL,S,UL,UL,UL,	DL,S,UL,UL,UL
Conf. of Special Subframe	Conf. 0				
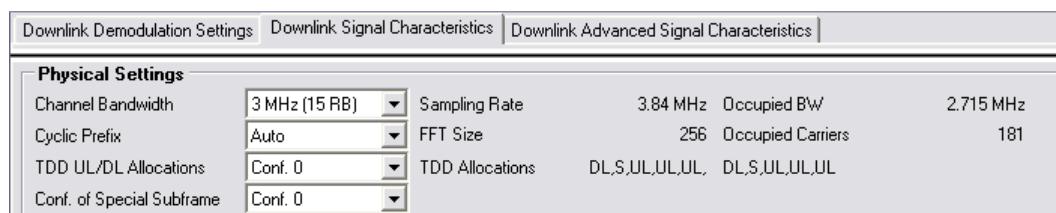
Channel Bandwidth / Number of Resource Blocks
Specifies the channel bandwidth and number of resource blocks (RB).

The channel bandwidth and number of resource blocks (RB) are interdependent. Currently, the LTE standard recommends six bandwidths (see table below).

The software also calculates the FFT size, sampling rate, occupied bandwidth and occupied carriers from the channel bandwidth. Those are read only.

Channel Bandwidth [MHz]	1.4	3	5	10	15	20
Number of Resource Blocks	6	15	25	50	75	100
Sample Rate [MHz]	1.92	3.84	7.68	15.36	30.72	30.72
FFT Size	128	256	512	1024	2048	2048

The software shows the currently selected LTE mode (including the bandwidth) in the header table.

Remote command:
CONFigure[:LTE]:DL[:CC<cci>]:BW on page 184

Cyclic Prefix

The cyclic prefix serves as a guard interval between OFDM symbols to avoid interferences. The standard specifies two cyclic prefix modes with a different length each.

The cyclic prefix mode defines the number of OFDM symbols in a slot.

- Normal
  A slot contains 7 OFDM symbols.
- Extended
  A slot contains 6 OFDM symbols.
  The extended cyclic prefix is able to cover larger cell sizes with higher delay spread of the radio channel.
- Auto
  The application automatically detects the cyclic prefix mode in use.

The software shows the currently selected cyclic prefix in the header table.

Remote command:
CONFigure[:LTE]:DL[:CC<cci>]:CYCPrefix on page 184

Configuring TDD Frames

TDD frames contain both uplink and downlink information separated in time with every subframe being responsible for either uplink or downlink transmission. The standard specifies several subframe configurations or resource allocations for TDD systems.

TDD UL/DL Allocations

Selects the configuration of the subframes in a radio frame in TDD systems.

The UL/DL configuration (or allocation) defines the way each subframe is used: for uplink, downlink or if it is a special subframe. The standard specifies seven different configurations.

Configuration	Subframe Number and Usage									
	0	1	2	3	4	5	6	7	8	9
0	D	S	U	U	U	D	S	U	U	U
1	D	S	U	U	D	D	S	U	U	D
2	D	S	U	D	D	D	S	U	D	D
3	D	S	U	U	U	D	D	D	D	D
4	D	S	U	U	D	D	D	D	D	D
5	D	S	U	D	D	D	D	D	D	D
6	D	S	U	U	U	D	S	U	U	D

U = uplink
D = downlink
S = special subframe

Conf. of Special Subframe

In combination with the cyclic prefix, the special subframes serve as guard periods for switches from uplink to downlink. They contain three parts or fields.

- DwPTS
  The DwPTS is the downlink part of the special subframe. It is used to transmit down-link data.
- GP
  The guard period makes sure that there are no overlaps of up- and downlink signals during a switch.
- UpPTS
  The UpPTS is the uplink part of the special subframe. It is used to transmit uplink data.

The length of the three fields is variable. This results in several possible configurations of the special subframe. The LTE standard defines 10 different configurations for the special subframe. However, configurations 8 and 9 only work for a normal cyclic prefix.

If you select configurations 8 or 9 using an extended cyclic prefix or automatic detection of the cyclic prefix, the software will show an error message.

Remote command:
Subframe
CONFigure[:LTE]:DL[:CC<cci>]:TDD:UDConf on page 184
Special Subframe
CONFigure[:LTE]:DL[:CC<cci>]:TDD:SPSC on page 185

5.2.2 Configuring the Physical Layer Cell Identity

The physical signal characteristics contain settings to describe the physical attributes of a downlink LTE signal.

The physical settings are part of the "Downlink Signal Characteristics" tab of the "Demod-ulation Settings" dialog box.

Configuring the Physical Layer Cell Identity

The cell ID, cell identity group and physical layer identity are interdependent parameters. In combination they are responsible for synchronization between network and user equipment.

The physical layer cell ID identifies a particular radio cell in the LTE network. The cell identities are divided into 168 unique cell identity groups. Each group consists of 3 physical layer identities. According to

$$N_{ID}^{cell} = 3 \cdot N_{ID}^{(1)} + N_{ID}^{(2)}$$

$N^{(1)}$ = cell identity group, {0...167}
$N^{(2)}$ = physical layer identity, {0...2}

there is a total of 504 different cell IDs.

If you change one of these three parameters, the software automatically updates the other two.

For automatic detection of the cell ID, turn the "Auto" function on.

Before it can establish a connection, the user equipment must synchronize to the radio cell it is in. For this purpose, two synchronization signals are transmitted on the downlink. These two signals are reference signals whose content is defined by the "Physical Layer Identity" and the "Cell Identity Group".

The first signal is one of 3 possible Zadoff-Chu sequences. The sequence that is used is defined by the physical layer identity. It is part of the P-SYNC.

The second signal is one of 168 unique sequences. The sequence is defined by the cell identity group. This sequence is part of the S-SYNC.

In addition to the synchronization information, the cell ID also determines

● the cyclic shifts for PCFICH, PHICH and PDCCH mapping,
● the frequency shifts of the reference signal.

The software shows the currently selected cell ID in the header table.

Remote command:
Cell ID:
CONFigure[:LTE]:DL[:CC<cci>]:PLC:CID on page 185
Cell Identity Group:
CONFigure[:LTE]:DL[:CC<cci>]:PLC:CIDGroup on page 186
FETCh[:CC<cci>]:PLC:CIDGroup? on page 186
Identity
CONFigure[:LTE]:DL[:CC<cci>]:PLC:PLID on page 186
FETCh[:CC<cci>]:PLC:PLID? on page 187

5.2.3 Configuring MIMO Measurements

The "DUT MIMO Configuration" and the "Tx Antenna Selection" are the same as in the "Analyzer Config / MIMO Setup" tab (➔ "General Settings") - if you change them in one place, they are also changed in the other.

For more information see "MIMO Configuration" on page 72.

5.2.4 Configuring PDSCH Subframes

The software allows you to configure individual subframes that are used to carry the information of the PDSCH. The PDSCH (Physical Downlink Shared Channel) primarily carries all general user data. It therefore takes up most of the space in a radio frame.

If you turn "Auto Demodulation" on, the software automatically determines the subframe configuration for the PDSCH. In the default state, automatic configuration is on.
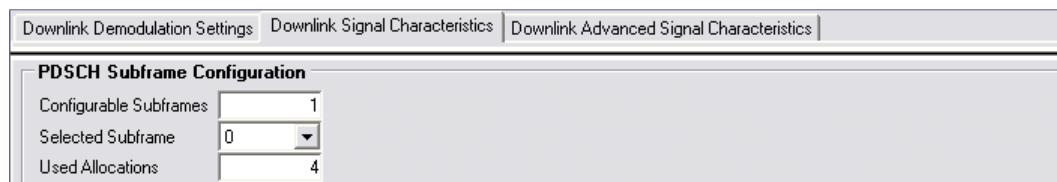
Every LTE frame (FDD and TDD) contains 10 subframes. Each downlink subframe consists of one or more (resource) allocations. The software shows the contents for each subframe in the configuration table. In the configuration table, each row corresponds to one allocation.

Subframe configuration errors

If there are any errors or conflicts between allocations in one or more subframes, the software shows a 🛑 icon in the column at the left of the table.

When you move the mouse over the icon, the software shows the kind of error.
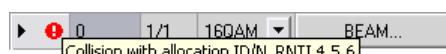
Before you start to work on the contents of each subframe, you should define the number of subframes you want to customize with the "Configurable Subframes" parameter. The software supports the configuration of up to 40 subframes.

Then you can select a particular subframe that you want to customize in the "Selected Subframe" field. Enter the number of the subframe (starting with 0). The software updates the contents of the configuration table to the selected subframe.

Configuring PDSCH Allocations

In the default state, each subframe contains one allocation. Add allocations with the "Used Allocations" parameter. The software expands the configuration table accordingly with one row representing one allocation. You can define a different number of allocations for each subframe you want to configure and configure up to 110 allocations in every subframe.

The configuration table contains the settings to configure the allocations.

- ID/N_RNTI
  Selects the allocation's ID. The ID corresponds to the N_RNTI.
  By default, the software assigns consecutive numbers starting with 0.
  The ID, or N_RNTI, is the user equipment identifier for the corresponding allocation and is a number in the range from 0 to 65535. The order of the numbers is irrelevant. You can combine allocations by assigning the same number more than once. Combining allocations assigns those allocations to the same user. Allocations with the same N_RNTI share the same modulation scheme and power settings.
- Code Word
  Shows the code word of the allocation.
  The code word is made up out of two numbers. The first number is the number of the code word in the allocation. The second number is the total number of code words that the allocation contains. Thus, a table entry of "1/2" would mean that the row corresponds to code word 1 out of 2 code words in the allocation.
  Usually one allocation corresponds to one code word. In case of measurements on a MIMO system (2 or 4 antennas) in combination with the "Spatial Multiplexing" precoding value, however, you can change the number of layers. Selecting 2 or more layers assigns two code words to the allocation. This results in an expansion of the configuration table. The allocation with the spatial multiplexing then comprises two rows instead of only one. Except for the modulation of the code word, which can be different, the contents of the second code word (row) are the same as the contents of the first code word.
- Modulation
  Selects the modulation scheme for the corresponding allocation.
  The modulation scheme for the PDSCH is either QPSK, 16QAM or 64QAM.
- Enhanced Settings
  For more information see "Selecting the Precoding Scheme" on page 94.
- VRB Gap
  Turns the use of virtual resource blocks (VRB) on and off.
  The standard defines two types of VRBs. Localized VRBs and distributed VRBs. While localized VRBs have a direct mapping to the PRBs, distributed VRBs result in a better frequency diversity.
  Three values of VRB gap are allowed.
  - **0** = Localized VRBs are used.
  - **1** = Distributed VRBs are used and the first gap is applied.
  - **2** = Distributed VRBs are used and the second gap is applied (for channel bandwidths > 50 resource blocks).
    The second gap has a smaller size compared to the first gap.

  If on, the VRB Gap determines the distribution and mapping of the VRB pairs to the physical resource blocks (PRB) pairs.
  The distribution of the VRBs is performed in a way that consecutive VRBs are spread over the frequencies and are not mapped to PRBs whose frequencies are next to

each other. Each VRB pair is split into two parts which results in a frequency gap between the two VRB parts. This method corresponds to frequency hopping on a slot basis.

The information whether localized or distributed VRBs are applied is carried in the PDCCH. The DCI formats 1A, 1B and 1D provide a special 1-bit flag for this purpose ("Localized / Distributed VRB Assignment"). Another bit in the DCI formats controls whether the first or second bit is applied.

● Number of RB

Defines the number of resource blocks the allocation covers. The number of resource blocks defines the size or bandwidth of the allocation.

If you allocate too many resource blocks compared to the bandwidth you have set. the software will show a 🔴 icon in the column at the left of the table.

● Offset RB

Sets the resource block at which the allocation begins.

A wrong offset for any allocation would lead to an overlap of allocations. In that case the software will show an error message.

● Power [dB]

Sets the boosting of the allocation. Boosting is the allocation's power relative to the reference signal power.

● Conflict

Move the mouse over the 🔴 icon to see details on the conflict. Possible conflicts are:

– Allocation exceeds available bandwidth

A bandwidth error occurs when the number of resource blocks in the subframe exceeds the bandwidth you have set.

Number of Allocations = 6

ID=5
ID 4
ID 3
ID 2
ID 1
ID 0

Subframe Bandwidth = 3 MHz or 15 Resource Blocks
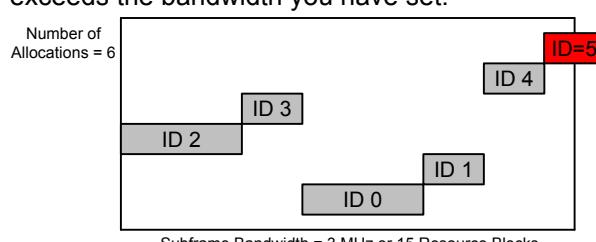
– Collision with allocation

An RB overlap error occurs if one or more allocations overlap. In that case, check if the length and offset values of the allocations are correct.
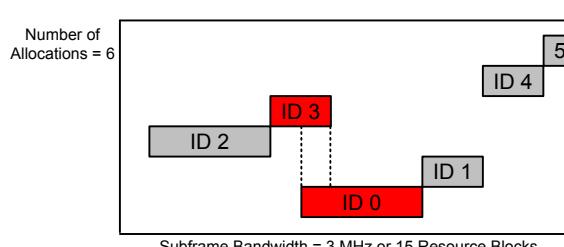
Number of Allocations = 6

5
ID 4
ID 3
ID 2
ID 1
ID 0

Subframe Bandwidth = 3 MHz or 15 Resource Blocks

Remote command:

See

Selecting the Precoding Scheme

The "Enhanced Settings" contain the functionality to configure the precoding scheme of a physical channel. The software supports several precoding schemes that you can select from a dropdown menu.

Precoding [Beamforming (UE-spec. RS) ▼]

- None
  Turns off precoding.
- Transmit Diversity
  Turns on precoding for transmit diversity according to 3GPP TS 36.211.
- Spatial Multiplexing
  Turns on precoding for spatial multiplexing according to 3GPP TS 36.211.
  If you are using spatial multiplexing, you can also define the number of layers for any allocation and the codebook index.
  The number of layers of an allocation in combination with the number of code words determines the layer mapping. The available number of layers depends on the number of transmission antennas. Thus, the maximum number of layers you can select is eight.

  Codeword-to-Layer Mapping
  Layers/Codewords
  1/1 ○ 2/1 ○ 3/1 ○ 4/1 ○
  2/2 ○ 3/2 ○ 4/2 ⦿ 5/2 ○ 6/2 ○ 7/2 ○ 8/2 ○
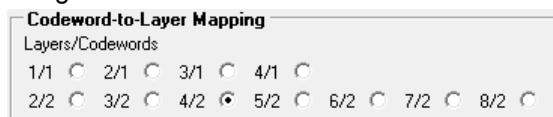
  The codebook index determines the precoding matrix. The available number of indices depends on the number of transmission antennas in use. The range is from 0 to 15. The software automatically selects the codebook index if you turn the "Cyclic Delay Diversity" (CDD) on.

  Spatial Multiplexing Settings
  Codebook Index
  0 ⦿ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○
  8 ○ 9 ○ 10 ○ 11 ○ 12 ○ 13 ○ 14 ○ 15 ○

  Cyclic Delay Diversity (CDD) ☐
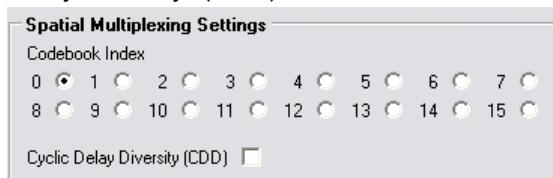
- Beamforming (UE Spec RS)
  Turns on the precoding for beamforming.
  If you are using beamforming, you can also define the number of layers and codewords (see "Spatial Multiplexing"), the scrambling identity and the single layer antenna port.
  The mapping of antenna port to the physical antenna is fixed:
  Port 5 and 7: Antenna 1
  Port 8: Antenna 2
  Port 9: Antenna 3
  Port 10: Antenna 4

  Beamforming Settings
  Scrambling Identity n_SCID   0 ⦿ 1 ○
  Single Layer Antenna Port [5   ▼]

  The scrambling identity (n_{SCID}) is available for antenna ports 7 and 8. It is used to initialize the sequence that generates UE specific reference signals according to 36.211 (section 6.10.3.1).

The single layer antenna port selects the preconfigured antenna port in single layer beamforming scenarios. Available if the codeword to layer mapping is "1/1".

● Carrier Aggregation
Defines the PDSCH start offset for the selected PDSCH allocation in a system that uses carrier aggregation.

For cross-scheduled UEs, the PDSCH start offset for the secondary carrier is usually not defined for each subframe individually but is constant over several subframes. In case the control channel region of the secondary component carrier is longer than the PDSCH start offset you have defined for the primary carrier, PDSCH resource elements might be overwritten by the resource elements of the control channel. Note that the bit stream result displays labels these resource element with a "#" sign.

Remote command:
See chapter 9.8.2.4, "Configuring PDSCH Subframes", on page 188

5.3 Defining Advanced Signal Characteristics

The downlink advanced signal characteristics contain settings that describe the detailed structure of a downlink LTE signal.

You can find the advanced signal characteristics in the "Demod Settings" dialog box.

5.3.1 Configuring the Synchronization Signal

The synchronization signal settings contain settings to describe the physical attributes and structure of the synchronization signal.

The synchronization signal settings are part of the "Downlink Advanced Signal Characteristics" tab of the "Demodulation Settings" dialog box.

P-/S-SYNC Tx Antenna

Selects the antenna that transmits the synchronization signal (P-SYNC or S-SYNC).

When selecting the antenna, you implicitly select the synchronization method. If the selected antenna transmits no synchronization signal, the software uses the reference signal to synchronize. Note that automatic cell ID detection is not available if synchronization is based on the reference signal.

Remote command:
CONFigure[:LTE]:DL[:CC<cci>]:SYNC:ANTenna on page 193

P-SYNC Relative Power

Defines the power of the primary synchronization signal (P-SYNC) relative to the reference signal.

Remote command:
CONFigure[:LTE]:DL:SYNC:PPOWer on page 193

S-SYNC Relative Power

Defines the power of the secondary synchronization signal (S-SYNC) relative to the reference signal.

Remote command:
CONFigure[:LTE]:DL:SYNC:SPOWer on page 193

5.3.2 Configuring the Reference Signal

The reference signal settings contain settings to describe the physical attributes and structure of the reference signal.

The reference signal settings are part of the "Downlink Advanced Signal Characteristics" tab of the "Demodulation Settings" dialog box.

Rel Power (Reference Signal)

Defines the relative power of the reference signal compared to all the other physical signals and physical channels.

Note that this setting gives you an offset to all other relative power settings.

Remote command:
CONFigure[:LTE]:DL:REFSig:POWer on page 194

5.3.3 Configuring Positioning Reference Signals

The positioning reference signal settings contain settings to describe the physical attributes and structure of the positioning reference signal.

Positioning reference signals are used to estimate the position of the user equipment.

Resource elements used by positioning reference signals are shown in blue color in the Allocation ID versus Symbol X Carrier measurement.

Note that PDSCH allocations will overwrite the positioning reference signal if they share a common resource block.

The positioning reference signal settings are part of the "Downlink Advanced Signal Characteristics" tab of the "Demodulation Settings" dialog box.

| Downlink Demodulation Settings | Downlink Signal Characteristics | Downlink Advanced Signal Characteristics |

Positioning Reference Signals Settings

| Present | ☑ | Configuration Index | 0 | Rel. Power | 0.000 dB |
| Bandwidth | 1.4 MHz (6 RB) ▼ | Num. Subframes (N_PRS) | 1 | Frame Number Offset | 0 |

Present

Turns the positioning reference signal on and off.

Remote command:

CONFigure[:LTE]:DL:PRSS:STATe on page 194

Bandwidth

Defines the bandwidth and thus the number of resource blocks the positioning reference signal occupies.

Note that the PRS bandwidth has to be smaller than the channel bandwidth.

Remote command:

CONFigure[:LTE]:DL:PRSS:BW on page 194

Configuration Index

Defines the PRS Configuration Index I_{PRS} as defined in 3GPP TS 36.211, table 6.10.4.3-1.

Remote command:

CONFigure[:LTE]:DL:PRSS:CI on page 194

Num. Subframes (N_PRS)

Defines the number of consecutive DL subframes in that PRS are transmitted.

Remote command:

CONFigure[:LTE]:DL:PRSS:NPRS on page 195

Relative Power (Positioning Reference Signal)
Defines the power of a PRS resource element in relation to the power of a common reference signal resource element.

Remote command:
CONFigure[:LTE]:DL:PRSS:POWer on page 195

Frame Number Offset
Defines the system frame number of the current frame that you want to analyze.

Because the positioning reference signal and the CSI reference signal usually have a periodicity of several frames, for some reference signal configurations is it necessary to change the expected system frame number of the frame to be analyzed.

Note that if you define the frame number offset for either reference signal, it is automatically defined for both reference signals.

Remote command:
CONFigure[:LTE]:DL:SFNO on page 195

5.3.4 Configuring Channel State Information Reference Signal

The channel state information reference signal (CSI-RS) settings contain settings to describe the physical attributes and structure of the Channel State Information Reference Signal (CSI-RS).

CSI-RS are used to estimate the channel properties of the signal propagation channel from the base station to the user equipement. This information is quantized and fed back to the base station. The base station makes use of this information for example to adjust the beamforming parameters.

The mapping of antenna port to the physical antenna is fix:

● Port 15: antenna 1

● Port 16: antenna 2

● Port 17: antenna 3

● Port 18: antenna 4

Resource elements used by CSI-RS are shown in yellow color in the Allocation ID versus Symbol X Carrier measurement.

The CSI-RS settings are part of the "Downlink Advanced Signal Characteristics" tab of the "Demodulation Settings" dialog box.

Present
Turns the CSI reference signal on and off.

Remote command:
CONFigure[:LTE]:DL:CSIRs:STATe on page 197

Antenna Ports
Defines the number of antenna ports that transmit the CSI reference signal.

The CSI reference signals are transmitted on one, two, four or eight antenna ports using

- p = 15
- p = 15 to 16
- p = 15 to 18
- p = 15 to 22

Remote command:
CONFigure[:LTE]:DL:CSIRs:NAP on page 196

Configuration Index
Defines the CSI reference signal configuration as defined in 3GPP TS 36.211, table 6.10.5.2-1/2

Remote command:
CONFigure[:LTE]:DL:CSIRs:CI on page 195

Subframe Configuration
Defines the CSI reference signal subframe configuration index (I_CSI-RS) as defined in 3GPP TS 36.211, table 6.10.5.3-1.

Remote command:
CONFigure[:LTE]:DL:CSIRs:SCI on page 196

Relative Power (CSI Reference Signal)
Defines the power of a CSI reference signal resource element in relation to the power of a common reference signal resource element.

Remote command:
CONFigure[:LTE]:DL:CSIRs:POWer on page 196

Frame Number Offset
Defines the system frame number of the current frame that you want to analyze.

Because the positioning reference signal and the CSI reference signal usually have a periodicity of several frames, for some reference signal configurations is it necessary to change the expected system frame number of the frame to be analyzed.

Note that if you define the frame number offset for either reference signal, it is automatically defined for both reference signals.

Remote command:
CONFigure[:LTE]:DL:SFNO on page 195

Overwrite PDSCH

Turns overwriting of PDSCH resource elements for UEs that do not consider the CSI reference signal on and off.

If on, the software assumes that the UE is not configured to consider CSI reference signals. Thus, resource elements of the CSI reference signal overwrite the PDSCH resource elements.

Note that the bit stream result displays labels these resource element with a "#" sign.

Remote command:
CONFigure[:LTE]:DL:CSIRs:OPDSch on page 196

5.3.5 Defining the PDSCH Resource Block Symbol Offset

PRB Symbol Offset

PRB Symbol Offset specifies the symbol offset of the PDSCH allocations relative to the subframe start. This setting applies to all subframes in a frame.

With this settings, the number of OFDM symbols used for control channels is defined, too. For example, if this parameter is set to 2 and the PDCCH is enabled, the number of OFDM symbols actually used by the PDCCH is 2.

Special control channels like the PCFICH or PHICH require a minimum number of control channel OFDM symbols at the beginning of each subframe. If PRB Symbol Offset is lower than the required value, the control channel data overwrites some resource elements of the PDSCH.

If Auto is selected, the Control Region for PDCCH (PRB Symbol Offset) value is detected from the PCFICH. For correct Demodulation of a 3GPP conform PCFICH signal, the Scrambling of Coded Bits has to be enabled.

Remote command:
CONFigure[:LTE]:DL:PSOFfset on page 200

5.3.6 Configuring the Control Channels

The control channel settings contain settings that describe the physical attributes and structure of the control channel.

The control channel settings are part of the "Downlink Advanced Signal Characteristics" tab of the "Demodulation Settings" dialog box.
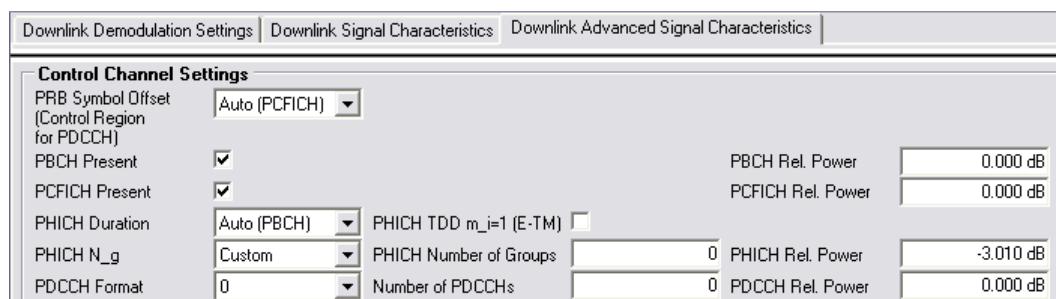
5.3.6.1 Configuring the PBCH

The physical broadcast channel (PBCH) carries system information for the user equip-
ment. You can include or exclude the PBCH in the test setup and define the relative power
of this channel.

PBCH Present
Includes or excludes the PBCH from the test setup.

Remote command:
CONFigure[:LTE]:DL:PBCH:STAT on page 197

PBCH Relative Power
Defines the power of the PBCH relative to the reference signal.

Remote command:
CONFigure[:LTE]:DL:PBCH:POWer on page 199

5.3.6.2 Configuring the PCFICH

The physical control format indicator channel (PCFICH) carries information about the
format of the PDCCH. You can include or exclude the PCFICH in the test setup and define
the relative power of this channel.

PCFICH Present
Includes or excludes the PCFICH from the test setup.

Remote command:
CONFigure[:LTE]:DL:PCFich:STAT on page 197

PCFICH Relative Power
Defines the power of the PCFICH relative to the reference signal.

Remote command:
CONFigure[:LTE]:DL:PCFich:POWer on page 199

5.3.6.3 Configuring the PHICH

The physical hybrid ARQ indicator channel (PHICH) contains the hybrid ARQ indicator.
The hybrid ARQ indicator contains the acknowledgement / negative acknowledgments
for uplink blocks.

You can set several specific parameters for the PHICH.

Turning off the PHICH

If you set the value of the PHICH N$_g$ to Custom and at the same time define "0" PHICH groups, the PHICH is excluded from the signal.

PHICH Duration

Selects the duration of the PHICH. Normal and extended duration are supported.

With a normal duration, all resource element groups of the PHICH are allocated on the first OFDM symbol.

With an extended duration, the resource element groups of the PHICH are distributed over three OFDM symbols for a normal subframe or over two symbols within a special subframe.

If you select Auto, the duration of PHICH is automatically determined and based on the PBCH decoding results.

Note that you have to turn on the PBCH for an automatic detemination of the PHICH duration.

Remote command:
CONFigure[:LTE]:DL:PHICh:DURation on page 198

PHICH TDD m_i=1 (E-TM)

Turns the special setting of the PHICH for the enhanced test models on and off.

The special setting is defined in 36.141 V9.0.0, 6.1.2.6: "For frame structure type 2 the factor m_i shall not be set as per TS36.211, Table 6.9-1, but instead shall be set to m_i=1 for all transmitted subframes."

The parameter is available if you have selected TDD.

Remote command:
CONFigure[:LTE]:DL:PHICh:MITM on page 199

PHICH N_g

Sets the variable N$_g$.

N$_g$ in combination with the number of resource blocks defines the number of PHICH groups in a downlink subframe. The standard specifies several values for N$_g$ that you can select from the dropdown menu.

If you need a customized configuration, you can set the number of PHICH groups in a subframe by selecting the "Custom" menu item and set a number of PHICH groups directly with PHICH Number of Groups.

Remote command:
CONFigure[:LTE]:DL:PHICh:NGParameter on page 198

PHICH Number of Groups

Sets the number of PHICH groups contained in a subframe.

To select a number of groups, you have to set the PHICH N_g to "Custom".

Remote command:
CONFigure[:LTE]:DL:PHICh:NOGRoups on page 199

PHICH Rel Power

Defines the power of the PHICH relative to the reference signal.

Remote command:

CONFigure[:LTE]:DL:PHICh:POWer on page 200

5.3.6.4 Configuring the PDCCH

The physical downlink control channel (PDCCH) carries the downlink control information.

The PDCCH is always present. You can define several specific parameters for the PDCCH.

PDCCH Format

Defines the format of the PDCCH (physical downlink control channel).

Note that PDCCH format "-1" is not defined in the standard. This format corresponds to the transmission of one PDCCH on all available resource element groups. As a special case for this PDCCH format, the center of the constellation diagram is treated as a valid constellation point.

Remote command:

CONFigure[:LTE]:DL:PDCCh:FORMat on page 198

Number of PDCCHs

Sets the number of physical downlink control channels.

This parameter is available if the PDCCH format is -1.

Remote command:

CONFigure[:LTE]:DL:PDCCh:NOPD on page 199

PDCCH Rel Power

Defines the power of the PDCCH relative to the reference signal.

Remote command:

CONFigure[:LTE]:DL:PDCCh:POWer on page 200

5.3.7 Configuring the Shared Channel

The shared channel settings contain settings that describe the characteristics of the shared channels.

The shared channel settings are part of the "Downlink Advanced Signal Characteristics" tab of the "Demodulation Settings" dialog box.

PDSCH Power Ratio

Selects the PDSCH P_B parameter that defines the cell-specific ratio of rho_B to rho_A according to 3GPP TS 36.213, table 5.2-1.

The table below shows the resulting values as a function of the number of antennas.

PDSCH P_B	1 Tx antenna	2 and 4 Tx antennas
0	0.000 dB	0.969 dB
1	-0.969 dB	0.000 dB
2	-2.218 dB	-1.249 dB
3	-3.979 dB	-3.010 dB

If you select "p_B/p_A=1", the ratio is always 1, regardless of the number of antennas.

Remote command:

CONFigure[:LTE]:DL:PDSCh:PB on page 201

6 Analyzing Measurement Results

The measurement software provides several tools to get more detailed information on the measurement results. The corresponding tools are part of the context menu.

► To access the context menu, click anywhere in the diagram grid with the right mouse button.
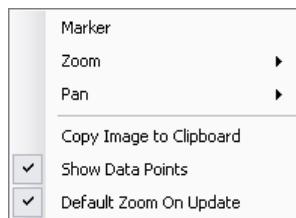
Fig. 6-1: Context menu

Using the marker

You can use a marker to get the coordinates of a single point in the diagram area.

► Open the context menu and select the "Marker" menu item.
   When the marker is active, the software puts a check mark ( ) in front of the "Marker" menu item.

When you turn it on, the software positions the marker on the trace maximum. After that you can move it around freely to any point of the trace.

Marker positioning
If you try to put the marker on a coordinate not occupied by the trace, the software puts the marker to the nearest trace maximum (if you place it above the trace) or the nearest trace minimum (if you place it below the trace).

The marker coordinates are displayed in the upper left area of the diagram. The first number shows the vertical position, the second number the horizontal position of the marker including the units.

If you want to reposition the marker on the trace maximum after moving it around, you have to first deactivate the marker and then reactivate it.

To deactivate the marker, open the context menu and reselect the "Marker" menu item.

Note that the marker is not available for all measurements and result displays.

Zooming into the diagram area

If you'd like to see parts of the diagram area in more detail, you can use the zoom.

► Open the context menu and select the "Zoom" menu item.
The software opens a submenu with several zooming options.
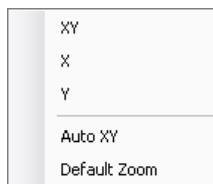
Fig. 6-2: Zooming options

- Zooming vertically and horizontally (XY)
  Click on any point in the diagram area and draw a rectangle with the mouse. The rectangle defines the part of the diagram area you are zooming into.
- Zooming horizontally (X)
  Click on any point in the diagram area and define the horizontal section of the diagram area you want to zoom into.
- Zooming vertically (Y)
  Click on any point in the diagram area and define the vertical section of the diagram area you want to zoom into.
- Zooming automatically (Auto XY)
  Automatically scales the diagram area so that the complete trace data is visible. Double-clicking on the diagram has the same effect.
- Restoring the default zoom
  The "Default Zoom" entry restores the default zoom.

The software also provides functionality to restore the default zoom each time when the display is updated.

► Open the context menu and select the "Default Zoom on Update" menu item.

Panning the trace

If you'd like to see parts of the measurement results that are outside the diagram area, you can move the contents of the diagram area. To move the contents of the diagram area, click anywhere in the diagram area and drag the contents of the diagram area until the parts you'd like to see are visible.

If there are parts of the trace data that are outside the visible display area, the software shows arrows to the right of the diagram area.

The arrows point in the direction where the invisible trace data is. If parts of the trace data is outside the visible area, the arrows are yellow. If all data in a particular direction is outside the visible area, the arrows turn red.

To make sure that the whole trace is always visible, you can use the automatic zoom ("Auto XY") available in the "Zoom" menu.

► Open the context menu and select the "Pan" menu item.
  The software opens a submenu with several panning options.
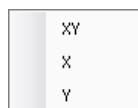
Fig. 6-3: Panning options

- Panning vertically and horizontally (XY)
  Panning is possible in all directions.
- Panning horizontally (X)
  Panning is possible to the left and right.
- Panning vertically (Y)
  Panning is possible upwards and downwards.

Copying an image to the clipboard

If you want to document measurement results, you can move a copy of them to the clipboard of the operating system.

► Open the context menu and select the "Copy to Clipboard" menu item.

7   Data Management

For easy handling of special measurement configurations, the software allows you to import or export various kinds of data.

7.1   Importing and Exporting I/Q Data

Instead of capturing data directly through hardware components, you can also analyze data that has been recorded previously and saved in a file. On the same lines, it is also possible to save the data that has been captured with an analyzer for further analysis at a later time or for documentation.

You can store and load I/Q data in binary or ASCII format. For a correct display of the power, the I/Q data has to be scaled linearily in Volt (e.g. for the Capture Buffer result display).

Loading I/Q data

Load the contents of an I/Q data file into the software fast and easy by dragging and dropping the file somwhere into the user interface.

The software updates the I/Q data to be measured automatically.

All functionality to import and export data is in the "File" menu (or file manager) that you can access via the FILE key.

ASCII format (.dat format)

In case of the ASCII (.dat) format, the data is expected as I and Q values in alternating rows.

<I value 1>

<Q value 1>

<I value 2>

<Q value 2>

(...)

To be able to analyze previously recorded data, you have to set the input source to "File". When you start a measurement, the software will ask you to select a file that contains the data.

To save data, enter the file manager and save the data with "Save IQ Data".

Binary format (.iqw format)

In case of the binary .iqw format, the data is expected in 32-bit floating point format. This format is also known as Little Endian, LSB Order or Intel format.

Example:

The hexadecimal value 0x1D86E7BB would be decoded to -7.0655481E-3.

For single antenna measurements, the order of the I/Q data is either IQIQIQ... or II...IQQ...Q.

For MIMO measurements, you also have to consider the antenna in the order of the data, with alternating I and Q data for every antenna.

[I/Q][antenna index]([symbol index])

Example:

For a two antenna system, the string of data would like:

I0(0),Q0(0),I1(0),Q1(0),I0(1),Q0(1),I1(1),Q1(1),I0(2),Q0(2),...

Binary format (.iq.tar format)

In case of the .iq.tar format, the I/Q data is stored in a compressed format with the file extension .iq.tar.

An .iq.tar file contains I/Q data in binary format together with meta information that describes the nature and the source of data, e.g. the sample rate. The objective of the .iq.tar file format is to separate I/Q data from the meta information while still having both inside one file. In addition, the file format allows you to preview the I/Q data in a web browser, and allows you to include customized data.

An .iq.tar file must contain the following files.

● I/Q parameter XML file
  Contains meta information about the I/Q data (e.g. sample rate). The filename can be defined freely, but there must be only one single I/Q parameter XML file inside an .iq.tar file.
● I/Q data binary file
  Contains the binary I/Q data of all channels. There must be only one single I/Q data binary file inside an .iq.tar file.

Optionally, an .iq.tar file can contain the following file.

● I/Q preview XSLT file
  Contains a stylesheet to display the I/Q parameter XML file and a preview of the I/Q data in a web browser.

7.2 Managing Frame Data

For fast access to the frame description (or structure of a signal), you can save it and again use it at a later time. To manage frame descriptions, enter the file manager and select "Save Demod Setup" to save the current setup or "Load Demod Setup" to restore a previously created setup.

The frame decription contains the complete modulation structure of the signal.

The frame structure is defined in the xml file format. The file contains all parameters that are part of the demodulation settings. If you want to define more than one allocation, you can do so by adding additional PRB entries (`<PRB>` element).

Note the following restrictions for the frame description.

- You have to define at least one PRB.
- You can allocate a maximum of four frames.

The example below shows a typical frame description.

```
<FrameDefinition LinkDirection="downlink" TDDULDLAllocationConfiguration="0"
TDDSpecialSubframeConfiguration="0" RessourceBlocks="50" CP="auto" PSYNCBoostingdB="0"
SSYNCBoostingdB="0" PSSYNCTxAntenna="All" ReferenceSignalBoostingdB="0"
PBCHIsPresent="true" PBCHBoostingdB="0" PCFICHIsPresent="true" PCFICHBoostingdB="0"
PHICH_Ng="1" PHICHNumGroups="0" PHICHDuration="Normal" PHICHBoostingdB="-3.01"
PHICHTDDSetMiAccToETMs="false" NumberOfPDCCHs="0" PDCCHFormat="-1"
PDCCHBoostingdB="0" PSSYNCRepetitionPeriod="10" DataSymbolOffsetSubFrame="-1"
MIMOConfiguration="1 Tx Antenna" MIMOAntennaSelection="Antenna 1"
PhysLayCellIDGrp="Auto" PhysLayID="Auto" RefSignal3GPPVersion="3"
N_c_fastforward="1600">
  <Frame>
    <Subframe>
      <PRBs>
        <PRB Start="0" Length="6" Boosting="0" Modulation="QPSK" Precoding="None"
        Layers="1" Codebook="0" CDD="0" N_RNTI="0"></PRB>
      </PRBs>
    </Subframe>
  </Frame>
  <stControl PhaseTracking="1" TimingTracking="0" ChannelEstimation="1"
  EVMCalculationMethod="1" CompensateCrosstalk="0" EnableScrambling="1"
  AutoDemodulation="1" AutoBoostingEstimation="1" SubframeConfDetect="2"
  RefDataSource="1" MulticarrierFilter="0"></stControl>
</FrameDefinition>
```

7.3 Importing and Exporting Limits

In addition to the limits defined by the standard, you can create and use customized limits. After you have created the file, you have to name it Default.eutra_limits and copy it into the same folder as the software binary ("%Program folder%\Rohde-Schwarz\EUTRA LTE" by default). The limits are automatically loaded when you start the software.

The limits you can customize work for the Result Summary.

Limits are defined in the xml file format. Any xml elements you do not want to define can be left out, either by making no entry or by deleting the corresponding element.

```
<Limits>
 <DL>
  <EVM>
   <PDSCHQPSK Mean="0.175"></PDSCHQPSK><!--Unit: linear (1 = 0 dB, 0.1 = -20 dB)-->
```

```
      <PDSCH16QAM Mean="0.125"></PDSCH16QAM><!--Unit: linear (1 = 0 dB, 0.1 = -20 dB)-->
      <PDSCH64QAM Mean="0.08"></PDSCH64QAM><!--Unit: linear (1 = 0 dB, 0.1 = -20 dB)-->
      <PhysicalChannel></PhysicalChannel><!--Unit: linear (1 = 0 dB, 0.1 = -20 dB)-->
      <PhysicalSignal></PhysicalSignal><!--Unit: linear (1 = 0 dB, 0.1 = -20 dB)-->
      <All></All><!--Unit: linear (1 = 0 dB, 0.1 = -20 dB)-->
    </EVM>
    <FrequencyError></FrequencyError><!--Unit: [Hz]-->
    <SamplingClockError></SamplingClockError><!--Unit [ppm]-->
    <TimeAlignmentError></TimeAlignmentError><!--Unit [ns]-->
    <IQOffset></IQOffset><!--Unit: linear (1 = 0 dB, 0.1 = -20 dB)-->
    <IQGainImbalance></IQGainImbalance><!--Unit: linear (1 = 0 dB, 0.1 = -20 dB)-->
    <IQQuadraturError></IQQuadraturError><!--Unit: [°]-->
    <OSTP></OSTP><!--Unit: [W]-->
    <PowerTotal></PowerTotal><!--Unit: [W]-->
    <CrestFactor></CrestFactor><!--Unit: linear (1 = 0 dB, 10 = 10 dB)-->
    <OffPowSpectralDensity Limit="-85"></OffPowSpectralDensity><!--Unit: [dBm/MHz]-->
  </DL>
</Limits>
```

8 Measurement Basics

This chapter provides background information on the measurements and result displays available with the LTE Analysis Software.

8.1 Symbols and Variables

The following chapters use various symbols and variables in the equations that the measurements are based on. The table below explains these symbols for a better understanding of the measurement principles.

$a_{l,k} \hat{a}_{l,k}$	data symbol (actual, decided)
$b_{l,k}$	boosting factor
Δf, $\Delta \hat{f}_{coarse}$	carrier frequency offset between transmitter and receiver (actual, coarse estimate)
Δf_{res}	residual carrier frequency offset
ζ	relative sampling frequency offset
$H_{l,k}$, $\hat{H}_{l,k}$	channel transfer function (actual, estimate)
i	time index
$\hat{i}_{coarse}$, $\hat{i}_{fine}$	timing estimate (coarse, fine)
k	subcarrier index
l	OFDM symbol index
N_{FFT}	length of FFT
N_g	number of samples in cyclic prefix (guard interval)
N_s	number of Nyquist samples
N_{RE}	number of resource elements
n	subchannel index, subframe index
$n_{l,k}$	noise sample
Φ_l	common phase error
$r(i)$	received sample in the time domain

$r_{l,k}$, $r'_{l,k}$, $r''_{l,k}$	received sample (uncompensated, partially compensated, equalized) in the frequency domain
T	useful symbol time
T_g	guard time
T_s	symbol time

8.2 Overview

The digital signal processing (DSP) involves several stages until the software can present results like the EVM.

The contents of this chapter are structured like the DSP.

8.3 The LTE Downlink Analysis Measurement Application

The block diagram in figure 8-1 shows the EUTRA/LTE downlink measurement application from the capture buffer containing the I/Q data to the actual analysis block. The outcome of the fully compensated reference path (green) are the estimates $â_{l,k}$ of the transmitted data symbols $a_{l,k}$. Depending on the user-defined compensation, the received samples $r''_{l,k}$ of the measurement path (yellow) still contain the transmitted signal impairments of interest. The analysis block reveals these impairments by comparing the reference and the measurement path. Prior to the analysis, diverse synchronization and channel estimation tasks have to be accomplished.

8.3.1 Synchronization

The first of the synchronization tasks is to estimate the OFDM symbol timing, which coarsely estimates both timing and carrier frequency offset. The frame synchronization block determines the position of the P-/S-Sync symbols in time and frequency by using the coarse fractional frequency offset compensated capture buffer and the timing estimate $\hat{i}_{coarse}$ to position the window of the FFT. If no P-/S-Sync is available in the signal, the reference signal is used for synchronization. The fine timing block prior to the FFT allows a timing improvement and makes sure that the EVM window is centered on the measured cyclic prefix of the considered OFDM symbol. For the 3GPP EVM calculation according to 3GPP TS 36.211 (v8.9.0), the block "window" produces three signals taken at the timing offsets $\Delta\tilde{t}$, $\Delta\tilde{t}_l$ and $\Delta\tilde{t}_h$. For the reference path, only the signal taken at the timing offset $\Delta\tilde{t}$ is used.

Fig. 8-1: Block diagram for the LTE DL measurement application

After the time to frequency transformation by an FFT of length N_{FFT}, the phase synchronization block is used to estimate the following:

- the relative sampling frequency offset ζ (SFO)
- the residual carrier frequency offset Δf_{res} (CFO)
- the common phase error Φ_l (CPE)

According to 3GPP TS 25.913 and 3GPP TR 25.892, the uncompensated samples can be expressed as

$$R_{l,k} = A_{l,k} \cdot H_{l,k} \cdot \underbrace{e^{j\Phi_l}}_{CPE} \cdot \underbrace{e^{j2\pi \cdot N_S/N_{FFT} \cdot \zeta \cdot k \cdot l}}_{SFO} \cdot \underbrace{e^{j2\pi \cdot N_S/N_{FFT} \cdot \Delta f_{res} \cdot T \cdot l}}_{res.CFO} + N_{l,k}$$

(8 - 1)

where

- the data symbol is $a_{l,k}$, on subcarrier k at OFDM symbol l
- the channel transfer function is $h_{l,k}$
- the number of Nyquist samples is N_s within the symbol time T_s
- the useful symbol time $T = T_s - T_g$
- the independent and Gaussian distributed noise sample is $n_{l,k}$

Within one OFDM symbol, both the CPE and the residual CFO cause the same phase rotation for each subcarrier, while the rotation due to the SFO depends linearly on the subcarrier index. A linear phase increase in symbol direction can be observed for the residual CFO as well as for the SFO.

The results of the tracking estimation block are used to compensate the samples $r_{l,k}$

Whereas a full compensation is performed in the reference path, the signal impairments that are of interest to the user are left uncompensated in the measurement path.

After having decided the data symbols in the reference path, an additional phase tracking can be utilized to refine the CPE estimation.

8.3.2 Channel Estimation and Equalizitaion

As shown in figure 8-1, there is one coarse and one fine channel estimation block. The reference signal-based coarse estimation is tapped behind the CFO compensation block (SFO compensation can optionally be enabled) of the reference path. The coarse estimation block uses the reference signal symbols to determine estimates of the channel transfer function by interpolation in both time and frequency direction. A special channel estimation ($\hat{H}_k^{3GPP}$) as defined in 3GPP TS 36.211 is additionally generated. The coarse estimation results are used to equalize the samples of the reference path prior to symbol decision. Based on the decided data symbols, a fine channel estimation is optimally performed and then used to equalize the partially compensated samples of the measurement path.

8.3.3 Analysis

The analysis block of the EUTRA/LTE downlink measurement application allows to compute a variety of measurement variables.

EVM

The error vector magnitude (EVM) measurement results 'EVM PDSCH QPSK/16-QAM/64-QAM' are calculated according to the specification in 3GPP TS 36.211.

All other EVM measurement results are calculated according to

$$EVM_{l,k} = \frac{\left| r_{l,k}'' - \hat{a}_{l,k} \right|}{b_{l,k} \sqrt{E\left\{ \left| \frac{a_{l,k}}{b_{l,k}} \right|^2 \right\}}}$$

(8 - 2)

on subcarrier k at OFDM symbol l, where $b_{l,k}$ is the boosting factor. Since the average power of all possible constellations is 1 when no boosting is applied, the equation can be rewritten as

$$EVM_{n,l} = \frac{\left| r_{l,k}'' - \hat{a}_{l,k} \right|}{b_{l,k}}$$

(8 - 3)

The average EVM of all data subcarriers is then

$$EVM_{data} = \sqrt{\frac{1}{N_{REdata}} \sum_{l} \sum_{k_{data}} EVM^2_{l,k_{data}}}$$

(8 - 4)

The number of resource elements taken into account is denoted by $N_{RE\ data}$.

I/Q imbalance

The I/Q imbalance can be written as

$$r(t) = I\,\Re\{s(t)\} + jQ\,\Im\{s(t)\}$$

(8 - 5)

where s(t) is the transmit signal, r(t) is the received signal, and I and Q are the weighting factors. We define that I:=1 and Q:=1+ΔQ.

The I/Q imbalance estimation makes it possible to evaluate the

$$\text{modulator gain balance} = |1 + \Delta Q|$$

(8 - 6)

and the

$$\text{quadrature mismatch} = \arg\{1 + \Delta Q\}$$

(8 - 7)

based on the complex-valued estimate $\Delta \hat{Q}$.

Other measurement variables

Without going into detail, the EUTRA/LTE downlink measurement application additionally provides the following results.

● Total power
● Constellation diagram
● Group delay
● I/Q offset
● Crest factor
● Spectral flatness

8.4 MIMO Measurement Guide

Measurements on LTE MIMO signals become available with option R&S FS(x)-K102(PC). Performing measurements on MIMO signals requires several signal analyzers or an oscilloscope with several channels - depending on the number of antennas in the MIMO system.

True MIMO measurements are useful to verifiy MIMO precoding implementations for setups where it is not possible to decode the transmit data using only one antenna (e.g.

applying spatial multiplexing MIMO precoding with more than 1 layer) and to measure the hardware performance of the MIMO transmitter hardware in a true MIMO measurement setup.

8.4.1 MIMO Measurements with Signal Analyzers

One analyzer acts as the master analyzer. The master analyzer is the reference oscillator source for all other analyzers (slaves). Therefore, you have to connect the REF IN of all slave analyzers to the REF OUT of the master analyzer. All slave analyzers must be set to external reference.

If you are using two R&S SMUs, the second R&S SMU has to be set to external reference as well, and the REF OUT of the first R&S SMU has to be connected to the REF IN of the second R&S SMU.

In order to capture the data simultaneously, you have to use a trigger signal. Thus, the device under test (DUT) or the R&S SMU has to provide a trigger signal. This trigger signal has to be connected to all analyzers.

If you are using two R&S SMU in the test setup, make sure to trigger the second R&S SMU by the first R&S SMU as well.

The figure 8-2 shows a MIMO hardware setup with 2 (or optional 4) analyzers and 1 (or optional 2) 2-channel R&S SMUs.
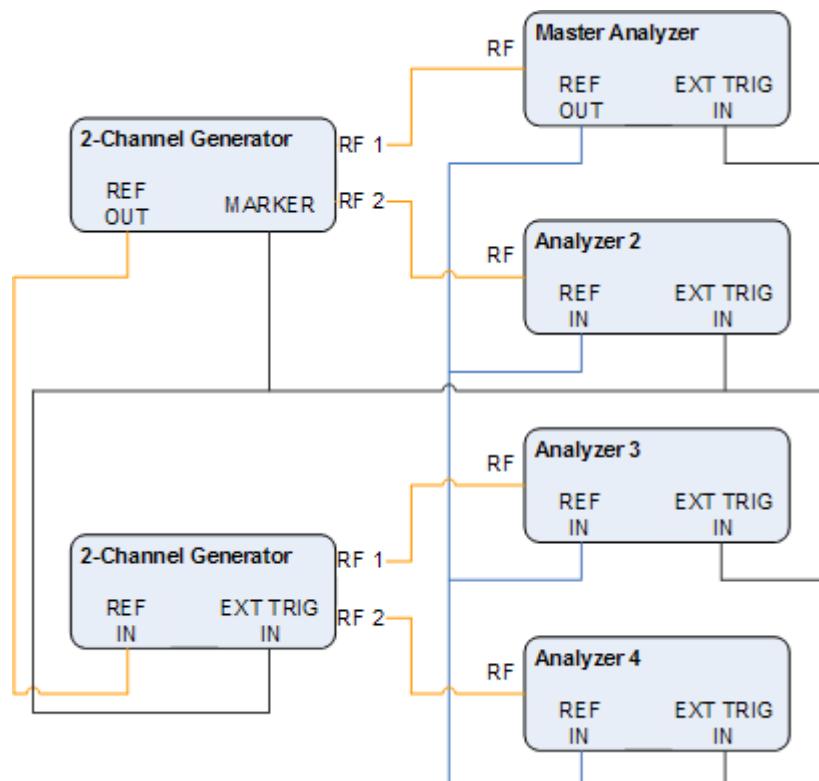

Fig. 8-2: MIMO Hardware Setup

8.4.1.1 Performing MIMO Measurements

The following measurement setups are possible without using special additional hardware.

Delayed trigger signal setup

Basically, it is mandatory to start the capturing of the I/Q data from each antenna simultaneously.

However, the connection between the analyzers and the software via LAN or GPIB causes a certain network delay. This network delay and tasks like the auto-level routine which need some time, result in a delay between the start of the measurement and the moment when the trigger inputs of all analyzers are armed. To make sure that the trigger event does not occur during this time frame, you have to define a delay between starting the measurement and sending the trigger signal.

The expected time to arm the trigger of one analyzer depends on the GPIB/network conditions and the input settings. To estimate the delay, initiate a single run measurement using only one analyzer and measure the time until the "DSP" indicator flashes. Note that this estimation also includes the time to transfer the I/Q samples from the instrument to the LTE software.

A typical delay to arm the trigger is 2 seconds per instrument.

The minimum delay of the trigger signal must now be greater than the measured time multiplied with the number of measured antennas (the number of analyzers), because the spectrum analyzers are initialized sequentially.

The usage of an LTE frame trigger is not possible for this measurement setup.

Frame trigger signal setup using identical LTE frames

You can use a frame trigger if all transmitted LTE frames use the same frame configuration and contain the same data. In this case, the analyzers in the test setup capture data from different LTE frames but with the same content.

This method to analyze data, however, raises one issue. The phase variations of the reference oscillators of the different signals that are transmitted are not the same, because the data is not captured simultaneously.

The result is a phase error which degrades the EVM (see the figures below).

An application for this measurement method is, for example, the test of the MIMO precoding implementation. Because of the bad EVM values, it is not recommended to use this test setup to measure hardware performance.
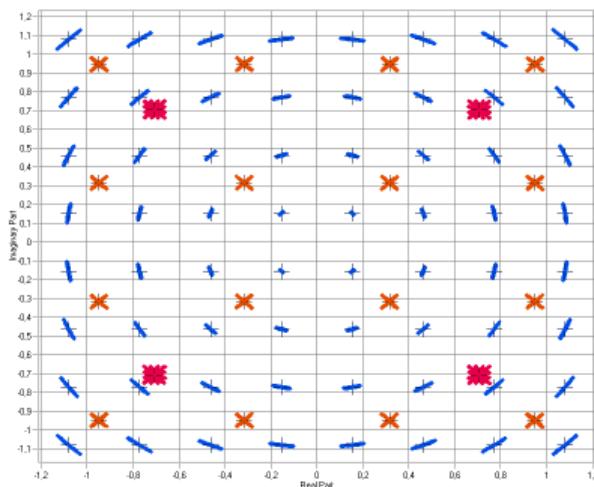
Fig. 8-3: Constellation diagram
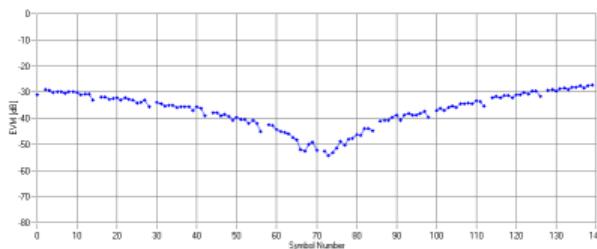
Fig. 8-4: EVM vs OFDM symbol number

8.4.1.2   Performing MIMO Measurements with a Trigger Unit

In MIMO test scenarios, you get the best results when all analyzers in the test setup simultaneously start to record the I/Q data. The trigger unit R&S FS-Z11 is a tool that makes sure that the measurement starts on all analyzers (master and slaves) at the same time.

Connecting the trigger unit to the analyzers

► Connect the NOISE SOURCE output of the master analyzer to the NOISE SOURCE CONTROL input of the trigger unit.

► Connect the EXT TRIG inputs of all analyzers (master **and** slaves) to the TRIG OUT 1 to 4 (or 1 and 2 in case of measurements on two antennas) of the trigger unit. The order is irrelevant, i.e. it would be no problem if you connect the master analyzer to the TRIG OUT 2 of the trigger unit.

With this setup, all analyzers (including the master analyzer) are triggered by the trigger unit.

The trigger unit also has a TRIG INPUT connector that you can connect an external trigger to. If you are using an external trigger, the external trigger supplies the trigger event. If

not, the analyzer noise source control supplies the trigger event. Note that if you do not use an external trigger, the TRIG INPUT must remain open.

To use the R&S FS-Z11 as the trigger source, you have to select it as the trigger source in the "General Settings" dialog box of the LTE measurement application. For more information see "Configuring the Trigger" on page 74.

8.4.2 MIMO Measurements with Oscilloscopes

This part presents an approach to measure a MIMO signal transmitted on two or four antennas using the R&S®RTO1044 digital oscilloscope, 4 GHz, 4 channels and the R&S®FS-K102/103PC LTE MIMO downlink/uplink PC software. This has multiple advantages:

● Only one measurement instrument is required. This not only reduces the number of test instruments but also simplifies the test setup and cabling (no reference oscillator and trigger cabling, no additional hardware for synchronization required like the R&S®FS-Z11).

● The measurement time is reduced.

For measuring LTE signals with the RTO it has to be equipped with the options R&S®RTO-B4 and R&S®RTO-K11.

The hardware setup is illustrated in figure 8-5. All transmit antennas (TX) of the device under test (DUT) or an SMU are connected to the RF input of the RTO. Either two or optionally four antennas are attached. The LTE-Software runs on a PC and is connected to the RTO via a local area network (LAN).
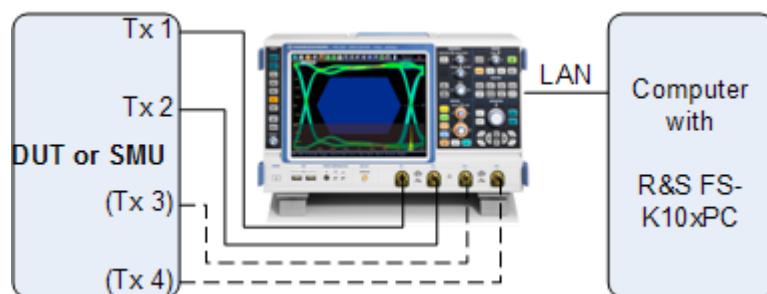
Fig. 8-5: Test setup for LTE MIMO measurements with an oscilloscope

To successfully connect the software to the oscilloscope, enter the correct network address in the "Analyzer Configuration" table and define the hardware properties (for example the number of input channels).
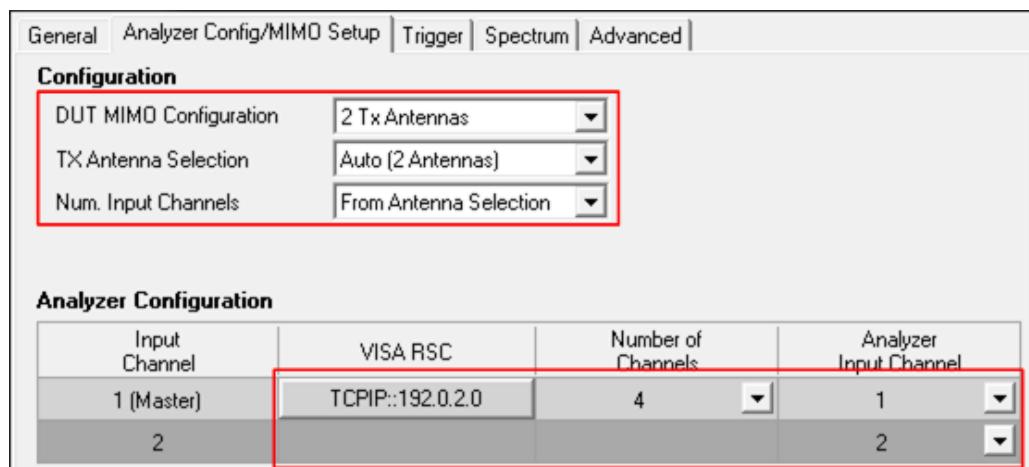
Fig. 8-6: Configuration of the R&S RTO connection and input channels

For configuring the number of active R&S RTO inputs the DUT MIMO configuration (2 Tx antennas or 4 Tx antennas) and the "Tx Antenna Selection" must be set. The DUT MIMO configuration describes which antennas are available and the Tx antenna selection defines how many I/Q data streams are captured and which antennas are assigned to the streams. To measure more than one antenna at once, "Tx Antenna Selection" must be set to "All", "Auto (2 Antennas)" or "Auto (4 Antennas)".

● "All": all available Tx antennas are measured and the antennas are assigned to the streams in ascending order.

● "Auto": the antenna assignment is automatically detected.
  In case of "Auto (2 Antennas)" two streams are captured.
  In case of "Auto (4 Antennas)" four streams are captured.

The signal level of each R&S RTO input channel is measured and the reference level and attenuation settings are adjusted automatically. If a manual setting is preferred and for speed optimization, the automatic level adjustment can be disabled in the "General" tab of the "General Settings" dialog box.

8.5 Performing Time Alignment Measurements

The measurement software allows you to perform Time Alignment measurements between different antennas.

You can perform this measurement in 2 or 4 Tx antenna MIMO setups.

The result of the measurement is the Time Alignment Error. The Time Alignment Error is the time offset between a reference antenna (for example antenna 1) and another antenna.

The Time Alignment Error results are summarized in the corresponding result display.

A schematic description of the results is provided in figure 8-7.
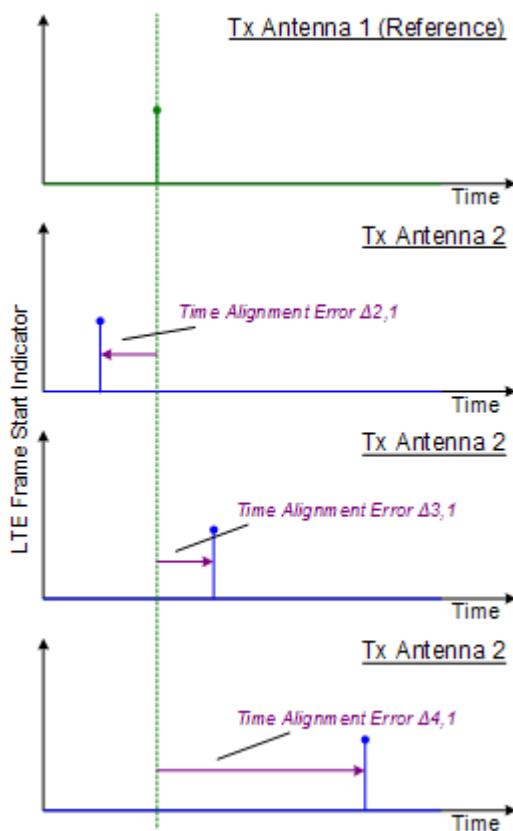
*Fig. 8-7: Time Alignment Error (4 Tx antennas)*

Test setup

Successful Time Alignment measurements require a correct test setup.

A typical hardware test setup is shown in figure 8-8. Note that the dashed connection are only required for MIMO measurements on 4 Tx antennas.
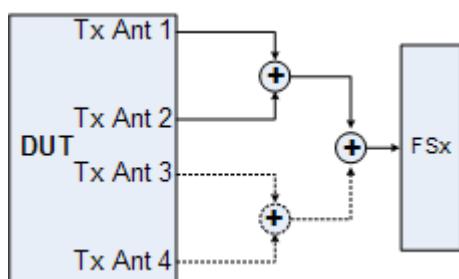

Fig. 8-8: Hardware setup

For best measurement result accuracy it is recommended to use cables of the same length and identical combiners as adders.

In the software, make sure to correctly apply the following settings.

- select a reference antenna in the MIMO Configuration dialog box (**not** "All")
- set the Subframe Selection to "All"

- Note that the Time Alignment meaurement only evaluates the reference signal and therefore ignores any PDSCH settings - for example, it does not have an influence on this measurement if the PDSCH MIMO scheme is set to transmit diversity or spatial multiplexing.

Time Alignment measurements with carrier aggregation

The test setup per component carrier is basically the same as measurements on a single carrier. You should, however, follow these guidelines for the best measurement results.

- Perform the measurement with an R&S RTO. Compared to an analyzer, the oscilloscope yields more accurate results in this case.
- If you perform the measurement with two analyzers, one analyzer is the master analyzer, the other is the slave. In that case, use the External Reference to synchronize the analyzers and use a trigger to make sure that the measurement starts at the same time on both analyzers. For a more comprehensive description of this test setup see chapter 8.4.1, "MIMO Measurements with Signal Analyzers", on page 117.
- Use a combiner to combine antennas for each carrier (as shown in figure 8-8).

8.6 Performing Transmit On/Off Power Measurements

The technical specification in 3GPP TS 36.141 prescribes the measurement of the transmitter OFF power and the transmitter transient period of an EUTRA/LTE TDD base transceiver station (BTS) operating at its specified maximum output power. A special hardware setup is required for this measurement since the actual measurement is done at very low power during the transmitter OFF periods requiring low attenuation at the analyzer input. The signal power during the transmitter ON periods in this test scenario is usually higher than the specified maximum input power of the R&S FSx signal analyzer and will cause severe damage to the analyzer if the measurement is not set up appropriately.

Test setup
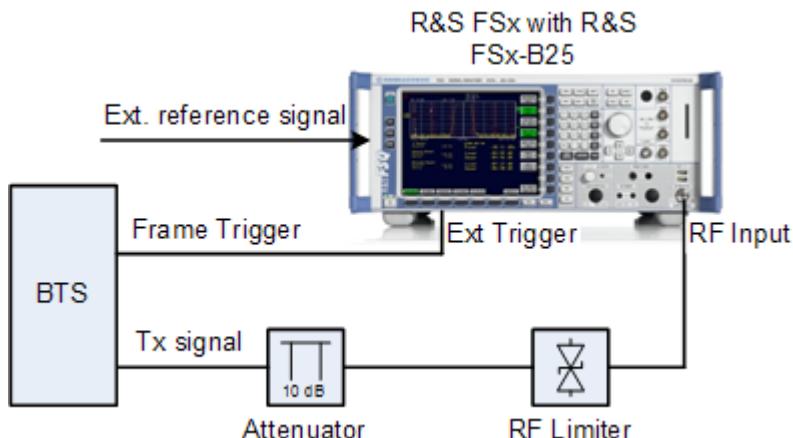
To protect the analyzer input from damage, an RF limiter has to be applied at the analyzer input connector, as can be seen in figure 2-16. Table 1.1 shows the specifications the used limiter has to fulfill.

Min. acceptable CW input power	BTS output power minus 10 dB
Min. acceptable peak input power	BTS peak output power minus 10 dB
Max. output leakage	20 dBm
Max. response time	1 µs
Max. recovery time	1 µs

An additional 10 dB attenuation should be placed in front of the RF limiter to absorb eventual reflected waves because of the high VSWR of the limiter. The allowed maximum CW input power of the attenuator must be lower than the maximum output power of the BTS.

Performing the measurement

For the transmit ON/OFF power measurements according to 36.141, 6.4, the test model E-TM1.1 has to be used. For more information on loading the test model settings see chapter 7, "Data Management", on page 108.

If an external trigger is used, before the actual measurement can be started, the timing must be adjusted by pressing the 'Adjust Timing' hotkey. The status display in the header of the graph changes from 'Timing not adjusted' to 'Timing adjusted' and the run hotkeys are released. Relevant setting changes again lead to a 'Timing not adjusted' status display.

If the adjustment fails, an error message is shown and the adjustment state is still "not adjusted". To find out what causes the synchronization failure, you should perform a regular EVM measurement (i.e. leave the ON/OFF Power measurement). Then you can use all the measurement results like EVM vs. Carrier to get more detailed information about the failure. The timing adjustment will succeed if the Sync State in the header is OK.

Using a R&S FSQ or R&S FSG it is recommended to use the external trigger mode since for high power signals a successful synchronization is not guaranteed under certain circumstances.

Pressing the 'Run Single' hotkey starts the averaging of the traces of the number of frames given in the 'General Settings' dialog. After performing all sweeps, the table in the upper half of the screen shows if the measurements pass or fail.

9 Remote Commands

When working via remote control, note that you have to establish a connection between your remote scripting tool and the software. Because the software runs directly on the PC and not an R&S instrument, you have to connect the remote scripting tool to your PC and not an instrument.

1. Start the software.

2. If you want to capture I/Q data from an analyzer, connect the software to that analyzer.

3. Start the remote scripting tool (e.g. Matlab) on the PC.

4. Connect the remote scripting tool to the local host (e.g. `TCPIC:LocalHost`)

9.1 Overview of Remote Command Suffixes

This chapter provides an overview of all suffixes used for remote commands in the LTE application.

Suffix	Range	Description
<allocation>	0 to 99	Selects an allocation.
<analyzer>	1 to 8	Selects an instrument for MIMO measurements.
<antenna>	2 to 4	Selects an antenna for MIMO measurements.
<cci>	1 to 2	Selects a component carrier Irrelevant for uplink measurements
<cluster>	1 to 2	Selects a cluster (uplink only).
<cwnum>	1 to n	Selects a codeword.
<k>		Selects a limit line. Irrelevant for the LTE software.

Suffix	Range	Description
<m>		Selects a marker. Irrelevant for the LTE software.
<n>	1 to 4	Selects a measurement window.
<subframe>	0 to 39	Selects a subframe.
<t>		Selects a trace. Irrelevant for the LTE application.

9.2 Introduction

Commands are program messages that a controller (e.g. a PC) sends to the instrument or software. They operate its functions ('setting commands') and request information ('query commands'). Some commands only work either way (setting only, query only), others work both ways (setting and query).

The syntax of a SCPI command consists of a so-called header and, in most cases, one or more parameters. A query command must append a question mark after the last header element, even if it contains a parameter.

A header contains one or more keywords, separated by a colon. Header and parameters are separated by a "white space" (ASCII code 0 to 9, 11 to 32 decimal, e.g. blank). If there is more than one parameter for a command, these are separated by a comma from one another.

This chapter summarizes the most important characteristics that you need to know when working with SCPI commands. For a more complete description, refer to the manual of one of the R&S analyzers.

Remote command examples

Note that some remote command examples mentioned in this introductory chapter may not be supported by this application.

9.2.1 Long and Short Form

The keywords have a long and a short form. You can use either the long or the short form, but no other abbreviations of the keywords.

The short form is emphasized in upper case letter. Note however, that this emphasis only serves the purpose to distinguish the short from the long form in the manual. For the instrument, the case does not matter.

Example:

`SENSe:FREQuency:CENTer` is the same as `SENS:FREQ:CENT`.

9.2.2 Numeric Suffixes

Some keywords have a numeric suffix if the command can be applied to multiple instances of an object. In that case, the suffix selects a particular instance (e.g. a measurement window).

Numeric suffixes are indicated by angular brackets (<n>) next to the keyword.

If you don't use a suffix for keywords that support one, it is treated as a 1.

Example:

`DISPlay[:WINDow<1...4>]:ZOOM:STATe` enables the zoom in a particular measurement window, selected by the suffix at `WINDow`.

`DISPlay:WINDow4:ZOOM:STATe ON` refers to window 4.

9.2.3 Optional Keywords

Some keywords are optional and are only part of the syntax because of SCPI compliance. You can include them in the header or not.

Note that if an optional keyword has a numeric suffix and you need to use the suffix, you have to include the optional keyword. Otherwise, the suffix is recognized as a 1.

Optional keywords are emphasized with square brackets.

Example:

Without a numeric suffix in the optional keyword:

`[SENSe:]FREQuency:CENTer` is the same as `FREQuency:CENTer`

With a numeric suffix in the optional keyword:

`DISPlay[:WINDow<1...4>]:ZOOM:STATe`

`DISPlay:ZOOM:STATe ON` enables the zoom in window 1 (no suffix).

`DISPlay:WINDow4:ZOOM:STATe ON` enables the zoom in window 4.

9.2.4 | (Vertical Stroke)

A vertical stroke indicates alternatives for a specific keyword. You can use both keywords to the same effect.

Example:

`[SENSe:]BANDwidth|BWIDth[:RESolution]`

In the short form without optional keywords, `BAND 1MHZ` would have the same effect as `BWID 1MHZ`.

9.2.5 SCPI Parameters

Many commands feature one or more parameters.

If a command supports more than one parameter, these are separated by a comma.

Example:

`LAYout:ADD:WINDow Spectrum,LEFT,MTABle`

Parameters may have different forms of values.

9.2.5.1 Numeric Values

Numeric values can be entered in any form, i.e. with sign, decimal point or exponent. In case of physical quantities, you can also add the unit. If the unit is missing, the command uses the basic unit.

Example:

with unit: `SENSe:FREQuency:CENTer 1GHZ`

without unit: `SENSe:FREQuency:CENTer 1E9` would also set a frequency of 1 GHz.

Values exceeding the resolution of the instrument are rounded up or down.

If the number you have entered is not supported (e.g. in case of discrete steps), the command returns an error.

Querying numeric values

When you query numeric values, the system returns a number. In case of physical quantities, it applies the basic unit (e.g. Hz in case of frequencies). The number of digits after the decimal point depends on the type of numeric value.

Example:

Setting: `SENSe:FREQuency:CENTer 1GHZ`

Query: `SENSe:FREQuency:CENTer?` would return `1E9`

In some cases, numeric values may be returned as text.

- INF/NINF
  Infinity or negative infinity. Represents the numeric values 9.9E37 or -9.9E37.

- NAN
  Not a number. Represents the numeric value 9.91E37. NAN is returned in case of errors.

9.2.5.2 Boolean

Boolean parameters represent two states. The "ON" state (logically true) is represented by "ON" or a numeric value 1. The "OFF" state (logically untrue) is represented by "OFF" or the numeric value 0.

Querying boolean parameters

When you query boolean parameters, the system returns either the value 1 ("ON") or the value 0 ("OFF").

Example:

Setting: `DISPlay:WINDow:ZOOM:STATe ON`

Query: `DISPlay:WINDow:ZOOM:STATe?` would return 1

9.2.5.3 Text

Text parameters follow the syntactic rules of keywords. You can enter text using a short or a long form. For more information see chapter 9.2.1, "Long and Short Form", on page 126.

Querying text parameters

When you query text parameters, the system returns its short form.

Example:

Setting: `SENSe:BANDwidth:RESolution:TYPE NORMal`

Query: `SENSe:BANDwidth:RESolution:TYPE?` would return NORM

9.2.5.4 Character Strings

Strings are either text or number. They have to be in straight quotation marks. You can use a single quotation mark - ' - or a double quotation mark - ".

Example:

`INSTRument:DELete 'Spectrum'`

9.2.5.5 Block Data

Block data is a format which is suitable for the transmission of large amounts of data.

The ASCII character # introduces the data block. The next number indicates how many of the following digits describe the length of the data block. In the example the 4 following digits indicate the length to be 5168 bytes. The data bytes follow. During the transmission of these data bytes all end or other control signs are ignored until all bytes are transmitted. #0 specifies a data block of indefinite length. The use of the indefinite format requires a NL^END message to terminate the data block. This format is useful when the length of

the transmission is not known or if speed or other considerations prevent segmentation of the data into blocks of definite length.

9.3 Remote Commands to Select a Result Display

CALCulate<n>:FEED <DispType>

This command selects the measurement and result display.

Parameters:

<DispType>   String containing the short form of the result display.

                            'BEAM:URWM' (UE RS Weights Magnitude)

                            'BEAM URWP' (UE RS Weights Phase)

                            'CONS:CONS' (Constellation diagram)

                            'EVM:EVCA' (EVM vs Carrier result display)

                            'EVM:EVRP' (EVM vs RB)

                            'EVM:EVSC' (EVM vs Symbol x Carrier)

                            'EVM:EVSU' (EVM vs Subframe result display)

                            'EVM:EVSY' (EVM vs Symbol result display)

                            'EVM:FEVS' (Frequency Error vs Symbol result display)

                            'PVT:CBUF' (Capture Buffer result display)

                            'PVT:OOP' (On/Off Power result display)

                            'PVT:TAER' (Time Alignment Error result display)

                            'SPEC:ACP' (ACLR)

                            'SPEC:FDIF' (Flatness Difference result display)

                            'SPEC:FLAT' (Spectrum Flatness result display)

                            'SPEC:GDEL' (Group Delay result display)

                            'SPEC:PSPE' (Power Spectrum result display)

                            'SPEC:PVRP' (Power vs RB PDSCH result display

                            'SPEC:PVRR' (Power vs RB RS result display)

                            'SPEC:PVSC' (Power vs Symbol x Carrier)

                            'SPEC:SEM' (Spectrum Emission Mask)

                            'STAT:AISC' (Allocation ID vs Symbol x Carrier)

                            'STAT:ASUM' (Allocation Summary)

                            'STAT:BSTR' (Bitstream)

                            'STAT:CCDF' (CCDF)

                            'STAT:CDR' (Channel Decoder results)

                            'STAT:SFLO' (Signal Flow)

Example: CALC2:FEED 'PVT:CBUF'

Select Capture Buffer to be displayed on screen B.

DISPlay[:WINDow<n>]:TABLe <State>

This command turns the result summary on and off.

Parameters:

<State>   **ON**

Turns the result summary on and removes all graphical results
from the screen.

OFF

Turns the result summary off and restores the graphical results
that were previously set.

Example: DISP:TABL OFF

Turns the result summary off.

9.4 Remote Commands to Perform Measurements

INITiate[:IMMediate]

This command initiates a new measurement sequence.

With a frame count > 0, this means a restart of the corresponding number of measurements.

In single sweep mode, you can synchronize to the end of the measurement with *OPC.
In continuous sweep mode, synchronization to the end of the sweep is not possible.

Example: INIT

Initiates a new measurement.

Usage: Event

INITiate:REFResh

This command updates the current I/Q measurement results to reflect the current measurement settings.

No new I/Q data is captured. Thus, measurement settings apply to the I/Q data currently in the capture buffer.

The command applies exclusively to I/Q measurements. It requires I/Q data.

Example:	INIT:REFR
	The application updates the IQ results

Usage:	Event

[SENSe]:SYNC[:STATe]?

This command queries the current synchronization state.

Return values:

<State>	The string contains the following information.
	• <OFDMSymbolTiming> is the coarse symbol timing
	• <P-SYNCSynchronization> is the P-SYNC synchronization state
	• <S-SYNCSynchronization> is the S-SYNC synchronization state
	A zero represents a failure and a one represents a successful synchronization.
	If no compatible frame has been found, the command returns '0,0,0'.

Example:	SYNC:STAT?
	Would return, e.g. '1,1,0' if coarse timing and P-SYNC were successful but S-SYNC failed.

Usage:	Query only

[SENSe][:LTE]:OOPower:ATIMing

This command adjusts the timing for On/Off Power measurements.

Example:	OOP:ATIM
	Adjusts the On/Off Power timing.

Usage:	Event

CONFigure[:LTE]:DL:CONS:LOCation <Location>

This command selects the data source of the constellation diagram for measurements on downlink signals.

Parameters:

<Location>	**AMD**
	After the MIMO decoder
	BMD
	Before the MIMO decoder
	*RST: BMD

Example:	CONF:DL:CONS:LOC AMD
	Use data from after the MIMO decoder.

CONFigure[:LTE]:DL:BF:AP <Port>

This command selects the antenna port for beamforming measurements.

The availabilty of ports depends on the number of transmit antennas and number of beamforming layers.

Parameters:

<Port>

> **AP_5_7**
> Antenna port 5/7.
>
> **AP_8**
> Antenna port 8.
>
> **AP_9**
> Antenna port 9.
>
> **AP_10**
> Antenna port 10.

9.5 Remote Commands to Read Numeric Results

FETCh:SUMMary:CRESt:MAXimum
FETCh:SUMMary:CRESt:MINimum
FETCh:SUMMary:CRESt[:AVERage]?

This command queries the average crest factor as shown in the result summary.

Return values:

<CrestFactor>   <numeric value>

                     Crest Factor in dB.

Example: FETC:SUMM:CRES?

                     Returns the current crest factor in dB.

Usage: Query only

FETCh:SUMMary:EVM[:ALL]:MAXimum?
FETCh:SUMMary:EVM[:ALL]:MINimum?
FETCh:SUMMary:EVM[:ALL][:AVERage]?

This command queries the EVM of all resource elements.

Return values:

<EVM>   <numeric value>

                     Minimum, maximum or average EVM, depending on the last com-
                     mand syntax element.
                     The unit is % or dB, depending on your selection.

Example: FETC:SUMM:EVM?
                      Returns the mean value.

Usage: Query only

FETCh:SUMMary:EVM:DSQP:MAXimum?
FETCh:SUMMary:EVM:DSQP:MINimum?
FETCh:SUMMary:EVM:DSQP[:AVERage]?

This command queries the EVM of all resource elements of the PDSCH with a QPSK modulation.

Return values:
<EVM>   <numeric value>

                      EVM in % or dB, depending on the unit you have set.

Example: FETC:SUMM:EVM:DSQP?
                      Returns the PDSCH QSPK EVM.

Usage: Query only

FETCh:SUMMary:EVM:DSST:MAXimum?
FETCh:SUMMary:EVM:DSST:MINimum?
FETCh:SUMMary:EVM:DSST[:AVERage]?

This command queries the EVM of all resource elements of the PDSCH with a 16QAM modulation.

Return values:
<EVM>   <numeric value>

                      EVM in % or dB, depending on the unit you have set.

Example: FETC:SUMM:EVM:DSST?
                      Returns the PDSCH 16QAM EVM.

Usage: Query only

FETCh:SUMMary:EVM:DSSF:MAXimum?
FETCh:SUMMary:EVM:DSSF:MINimum?
FETCh:SUMMary:EVM:DSSF[:AVERage]?

This command queries the EVM of all resource elements of the PDSCH with a 64QAM modulation.

Return values:
<EVM>   <numeric value>

                      EVM in % or dB, depending on the unit you have set.

Example: FETC:SUMM:EVM:DSSF?
                      Returns the PDSCH 64QAM EVM.

Usage: Query only

FETCh:SUMMary:EVM:PCHannel:MAXimum?
FETCh:SUMMary:EVM:PCHannel:MINimum?
FETCh:SUMMary:EVM:PCHannel[:AVERage]?

This command queries the EVM of all physical channel resource elements.

Return values:

<EVM>	<numeric value>
	Minimum, maximum or average EVM, depending on the last command syntax element. The unit is % or dB, depending on your selection.
Example:	FETC:SUMM:EVM:PCH? Returns the mean value.
Usage:	Query only

FETCh:SUMMary:EVM:PSIGnal:MAXimum?
FETCh:SUMMary:EVM:PSIGnal:MINimum?
FETCh:SUMMary:EVM:PSIGnal[:AVERage]?

This command queries the EVM of all physical signal resource elements.

Return values:

<EVM>	<numeric value>
	Minimum, maximum or average EVM, depending on the last command syntax element. The unit is % or dB, depending on your selection.
Example:	FETC:SUMM:EVM:PSIG? Returns the mean value.
Usage:	Query only

FETCh:SUMMary:FERRor:MAXimum?
FETCh:SUMMary:FERRor:MINimum?
FETCh:SUMMary:FERRor[:AVERage]?

This command queries the frequency error.

Return values:

<FreqError>	<numeric value>
	Minimum, maximum or average frequency error, depending on the last command syntax element. Default unit: Hz
Example:	FETC:SUMM:FERR? Returns the average frequency error in Hz.
Usage:	Query only

FETCh:SUMMary:GIMBalance:MAXimum?
FETCh:SUMMary:GIMBalance:MINimum?
FETCh:SUMMary:GIMBalance[:AVERage]?

This command queries the I/Q gain imbalance.

Return values:

<GainImbalance>   <numeric value>

Minimum, maximum or average I/Q imbalance, depending on the last command syntax element.

Default unit: dB

Example: FETC:SUMM:GIMB?

Returns the current gain imbalance in dB.

Usage: Query only

FETCh:SUMMary:IQOFfset:MAXimum?
FETCh:SUMMary:IQOFfset:MINimum?
FETCh:SUMMary:IQOFfset[:AVERage]?

This command queries the I/Q offset.

Return values:

<IQOffset>   <numeric value>

Minimum, maximum or average I/Q offset, depending on the last command syntax element.

Default unit: dB

Example: FETC:SUMM:IQOF?

Returns the current IQ-offset in dB

Usage: Query only

FETCh:SUMMary:OSTP:MAXimum?
FETCh:SUMMary:OSTP:MINimum?
FETCh:SUMMary:OSTP[:AVERage]?

This command queries the OSTP.

Return values:

<OSTP>   <numeric value>

Minimum, maximum or average OSTP, depending on the last command syntax element.

Default unit: dBm

Example: FETC:SUMM:OSTP?

Returns the current average OSTP value.

Usage: Query only

FETCh:SUMMary:POWer:MAXimum?
FETCh:SUMMary:POWer:MINimum?
FETCh:SUMMary:POWer[:AVERage]?

This command queries the total power.

Return values:

<Power>	<numeric value>
	Minimum, maximum or average power, depending on the last command syntax element.
	Default unit: dBm
Example:	FETC:SUMM:POW?
	Returns the total power in dBm
Usage:	Query only

FETCh:SUMMary:QUADerror:MAXimum?
FETCh:SUMMary:QUADerror:MINimum?
FETCh:SUMMary:QUADerror[:AVERage]?

This command queries the quadrature error.

Return values:

<QuadError>	<numeric value>
	Minimum, maximum or average quadrature error, depending on the last command syntax element.
	Default unit: deg
Example:	FETC:SUMM:QUAD?
	Returns the current mean quadrature error in degrees.
Usage:	Query only

FETCh[:CC<cci>]:SUMMary:RFERror:AVERage?

This command queries the frequency error of the component carriers.

Return values:

<Frequency Error>	Frequency error of the component carrier (CC2) relative to the main component carrier (CC1).
	Default unit: Hz
Example:	FETC:SUMM:RFER:AVER?
	Returns the frequency error in Hz.
Usage:	Query only

FETCh:SUMMary:RSSI:MAXimum
FETCh:SUMMary:RSSI:MINimum
FETCh:SUMMary:RSSI[:AVERage]?

This command queries the RSSI as shown in the result summary.

Return values:

<RSSI>	<numeric value>
	Minimum, maximum or average sampling error, depending on the last command syntax element.
	Default unit: dBm
Example:	FETC:SUMM:RSSI?
	Queries the average RSSI.
Usage:	Query only

FETCh:SUMMary:RSTP:MAXimum?
FETCh:SUMMary:RSTP:MINimum?
FETCh:SUMMary:RSTP[:AVERage]?

This command queries the RSTP as shown in the result summary.

Return values:

<RSTP>	RSTP in dBm.
Example:	FETC:SUMM:RSTP?
	Queries the RSTP.
Usage:	Query only

FETCh:SUMMary:SERRor:MAXimum?
FETCh:SUMMary:SERRor:MINimum?
FETCh:SUMMary:SERRor[:AVERage]?

This command queries the sampling error.

Return values:

<SamplingError>	<numeric value>
	Minimum, maximum or average sampling error, depending on the last command syntax element.
	Default unit: ppm
Example:	FETC:SUMM:SERR?
	Returns the current mean sampling error in ppm.
Usage:	Query only

FETCh:SUMMary:TFRame?

This command queries the (sub)frame start offset as shown in the Capture Buffer result display.

Return values:

<Offset>	Time difference between the (sub)frame start and capture buffer start.
	Default unit: s
Example:	FETC:SUMM:TFR?
	Returns the (sub)frame start offset.
Usage:	Query only

FETCh:TAERror[:CC<cci>]:ANTenna<antenna>:MAXimum
FETCh:TAERror[:CC<cci>]:ANTenna<antenna>:MINimum
FETCh:TAERror[:CC<cci>]:ANTenna<antenna>[:AVERage]?

This command queries the time alignment error.

Return values:

<Time Alignment Error>	Minimum, maximum or average time alignment error, depending on the last command syntax element.
	Default unit: s
Example:	FETC:TAER:ANT2?
	Returns the average time alignment error between the reference antenna and antenna 2 in s.
Usage:	Query only

9.6   Remote Commands to Read Trace Data

9.6.1   Using the TRACe[:DATA] Command

This chapter contains information on the TRACe:DATA command and a detailed description of the characteristics of that command.

The TRACe:DATA command queries the trace data or results of the currently active measurement or result display. The type, number and structure of the return values are specific for each result display. In case of results that have any kind of unit, the command returns the results in the unit you have currently set for that result display.

Note also that return values for results that are available for both downlink and uplink may be different.

For several result displays, the command also supports various SCPI parameters in combination with the query. If available, each SCPI parameter returns a different aspect of the results. If SCPI parameters are supported, you have to quote one in the query.

Example:

`TRAC2:DATA? TRACE1`

The format of the return values is either in ASCII or binary characters and depends on the format you have set with `FORMat[:DATA]`.

Following this detailed description, you will find a short summary of the most important functions of the command (`TRACe[:DATA]?`).

9.6.1.1 Adjacent Channel Leakage Ratio

For the ACLR result display, the number and type of returns values depend on the parameter.

● TRACE1
   Returns one value for each trace point of trace 1 (yellow). Trace 1 contains the absolute power values measured with a 1 MHz RBW.
   `<absolute power>, ...`
   The unit is always dBm.

● TRACE2
   Returns one value for each trace point of trace 2 (green). Trace 2 contains the absolute power values measured with a 100 kHz RBW.
   TRACE2 is available for relative ACLR measurements.

- LIST
  Returns the contents of the ACLR table.
  For each channel, it returns six values.
  `<bandwidth>, <spacing offset>, <power>, <delta to limit>,`
  `<frequency at delta to limit>, <limit check result>, ...`
  The channel order is: TX channel ➜ lower adjacent ➜ upper adjacent ➜ lower alternate ➜ upper alternate
  The unit of the `<bandwidth>,<spacing offset>` and `<frequency at delta to limit>` is Hz.
  The unit of the power is either dBc or dBm, depending on the ACLR measurement mode (relative or absolute).
  The `<limit check result>` is either a 0 (for PASS) or a 1 (for FAIL).
  Note that the TX channel does not have a `<spacing offset>,<delta to limit>,<frequency at delta to limit>` and `<limit check result>`. `NaN` is returned instead.

9.6.1.2 Allocation ID vs Symbol x Carrier

For the Allocation ID vs Symbol x Carrier, the command returns one value for each resource element.

`<ID[Symbol(0),Carrier(1)]>, ..., <ID[Symbol(0),Carrier(n)]>,`

`<ID[Symbol(1),Carrier(1)]>, ..., <ID[Symbol(1),Carrier(n)]>,`

`...`

`<ID[Symbol(n),Carrier(1)]>, ..., <ID[Symbol(n),Carrier(n)]>,`

The `<allocation ID>` is encoded. For the code assignment see chapter 9.6.1.26, "Return Value Codes", on page 152.

The following parameters are supported.
- TRACE1

9.6.1.3 Allocation Summary

For the Allocation Summary, the command returns seven values for each line of the table.

`<subframe>, <allocation ID>, <number of RB>, <relative power>,`
`<modulation>, <absolute power>, <EVM>, ...`

The unit for `<absolute power>` is always dBm. The unit for `<relative power>` is always dB. The unit for `<EVM>` depends on `UNIT:EVM`. All other values have no unit.

The `<allocation ID>` and `<modulation>` are encoded. For the code assignment see chapter 9.6.1.26, "Return Value Codes", on page 152.

Note that the data format of the return values is always ASCII.

Example:

TRAC:DATA? TRACE1 would return:

```
0, -5, 0, 0.0000000000000, 2, -45.5463829153428, 7.33728660354122E-05,

0, -3, 0, 0.0073997452251, 6, -42.5581007463452, 2.54197349219455E-05,

0, -4, 0, 0.0052647197362, 1, -42.5464220485716, 2.51485275782241E-05,

...
```

9.6.1.4   Bit Stream

For the Bit Stream result display, the command returns five values and the bitstream for each line of the table.

```
<subframe>, <allocation ID>, <codeword>, <modulation>, <# of
symbols/bits>, <hexadecimal/binary numbers>,...
```

All values have no unit. The format of the bitstream depends on Bit Stream Format.

The <allocation ID>, <codeword> and <modulation> are encoded. For the code assignment see chapter 9.6.1.26, "Return Value Codes", on page 152.

For symbols or bits that are not transmitted, the command returns

- "FF" if the bit stream format is "Symbols"
- "9" if the bit stream format is "Bits".

For symbols or bits that could not be decoded because the number of layer exceeds the number of receive antennas, the command returns

- "FE" if the bit stream format is "Symbols"
- "8" if the bit stream format is "Bits".

Note that the data format of the return values is always ASCII.

Example:

TRAC:DATA? TRACE1 would return:

```
0, -12, 0, 2, 0, 01, 01, 00, 02, 03, 00, 01, 02, 01, 02, 01, ...
```
```
<continues like this until the next data block starts or the end of data is
reached>
```
```
0, -12, 0, 2, 32, 03, 02, 03, 03, 03, 03, 01, 03, 00, 03, ...
```

9.6.1.5 Capture Buffer

For the Capture Buffer result display, the command returns one value for each I/Q sample
in the capture buffer.

```
<absolute power>, ...
```

The unit is always dBm.

The following parameters are supported.

- TRACE1

9.6.1.6 CCDF

For the CCDF result display, the type of return values depends on the parameter.

- TRACE1
  Returns the probability values (y-axis).
  ```
  <# of values>, <probability>, ...
  ```
  The unit is always %.
  The first value that is returned is the number of the following values.
- TRACE2
  Returns the corresponding power levels (x-axis).
  ```
  <# of values>, <relative power>, ...
  ```
  The unit is always dB.
  The first value that is returned is the number of the following values.

9.6.1.7 Channel Decoder Results

For the Channel Decoder Results, the number and type of return values depend on the
parameter.

- PBCH
  Returns the results for the PBCH if PBCH decoding (or CRC check) was successful.
  The results are made up out of six values.

`<subframe>, <# of antennas>, <system bandwidth>, <frame>, <PHICH duration>, <PHICH resource>`

The unit for `<system bandwidth>` is Hz. All other values have no unit.

The `<PHICH duration>` and `<PHICH resource>` are encoded. For the code assignment see chapter 9.6.1.26, "Return Value Codes", on page 152.

If PBCH decoding was not successful, the command returns NAN.

● PCFICH
Returns the results for the PCFICH. The results are made up out of two parameters.
`<subframe>, <number of symbols for PDCCH>`
The values have no unit.

● PHICH
Returns the results for the PHICH. The results are made up out of three values for each line of the table.
`<subframe>, <ACK/NACK>, <relative power>`
The unit for `<relative power>` is dB. All other values have no unit.

The `<ACK/NACK>` is encoded. For the code assignment see chapter 9.6.1.26, "Return Value Codes", on page 152.

● PDCCH
Returns the results for the PDCCH. The results are made up out of seven values for each line of the table.
`<subframe>, <RNTI>, <DCI format>, <PDCCH format>, <CCE offset>, <# of transmitted bits>, [stream of binary numbers]`
The values have no unit.

The `[stream of binary numbers]` is a list of binary numbers separated by comma.

The `<DCI format>` and `<PDCCH format>` are encoded. For the code assignment see chapter 9.6.1.26, "Return Value Codes", on page 152.

● PDSCH
Returns the results for the PDSCH. The results are made up out of five values for each line of the table.
`<subframe>, <allocationID>, <codeword>, <# of transmitted bits>, [stream of binary numbers]`
The values have no unit.

The `[stream of binary numbers]` is a list of binary numbers separated by comma.

If the PDSCH could not be decoded, the NAN is returned instead of the `<# of transmitted bits>`. The `[stream of binary numbers]` is not shown.

The `<allocationID>` and `<codeword>` are encoded. For the code assignment see chapter 9.6.1.26, "Return Value Codes", on page 152.

9.6.1.8   Channel Flatness

For the Channel Flatness result display, the command returns one value for each trace point.

`<relative power>, ...`

The unit is always dB.

The following parameters are supported.

- TRACE1
  Returns the average power over all subframes.
- TRACE2
  Returns the minimum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.
- TRACE3
  Returns the maximum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.

9.6.1.9 Channel Flatness Difference

For the Channel Flatness Difference result display, the command returns one value for each trace point.

```
<relative power>, ...
```

The unit is always dB. The number of values depends on the selected LTE bandwidth.

The following parameters are supported.

- TRACE1
  Returns the average power over all subframes.
- TRACE2
  Returns the minimum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.
- TRACE3
  Returns the maximum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.

9.6.1.10 Channel Group Delay

For the Channel Group Delay result display, the command returns one value for each trace point.

```
<group delay>, ...
```

The unit is always ns. The number of values depends on the selected LTE bandwidth.

The following parameters are supported.

- TRACE1
  Returns the group delay.

9.6.1.11 Constellation Diagram

For the Constellation Diagram, the command returns two values for each constellation point.

<I[SF0][Sym0][Carrier1]>, <Q[SF0][Sym0][Carrier1]>, ..., <I[SF0][Sym0][Carrier(n)]>, <Q[SF0][Sym0][Car-rier(n)]>,

<I[SF0][Sym1][Carrier1]>, <Q[SF0][Sym1][Carrier1]>, ..., <I[SF0][Sym1][Carrier(n)]>, <Q[SF0][Sym1][Car-rier(n)]>,

<I[SF0][Sym(n)][Carrier1]>, <Q[SF0][Sym(n)][Carrier1]>, ..., <I[SF0][Sym(n)][Carrier(n)]>, <Q[SF0][Sym(n)] [Carrier(n)]>,

<I[SF1][Sym0][Carrier1]>, <Q[SF1][Sym0][Carrier1]>, ..., <I[SF1][Sym0][Carrier(n)]>, <Q[SF1][Sym0][Car-rier(n)]>,

<I[SF1][Sym1][Carrier1]>, <Q[SF1][Sym1][Carrier1]>, ..., <I[SF1][Sym1][Carrier(n)]>, <Q[SF1][Sym1][Car-rier(n)]>,

<I[SF(n)][Sym(n)][Carrier1]>, <Q[SF(n)][Sym(n)][Carrier1]>, ..., <I[SF(n)][Sym(n)][Carrier(n)]>, <Q[SF(n)] [Sym(n)][Carrier(n)]>

With SF = subframe and Sym = symbol of that subframe.

The I and Q values have no unit.

The number of return values depends on the constellation selection. By default, it returns all resource elements including the DC carrier.

The following parameters are supported.

- TRACE1
  Returns all constellation points included in the selection.

9.6.1.12 EVM vs Carrier

For the EVM vs Carrier result display, the command returns one value for each subcarrier that has been analyzed.

`<EVM>, ...`

The unit depends on `UNIT:EVM`.

The following parameters are supported.

- TRACE1
  Returns the average EVM over all subframes
- TRACE2
  Returns the minimum EVM found over all subframes. If you are analyzing a particular subframe, it returns nothing.
- TRACE3
  Returns the maximum EVM found over all subframes. If you are analyzing a particular subframe, it returns nothing.

9.6.1.13 EVM vs RB

For the EVM vs RB result display, the command returns one value for each resource block that has been analyzed.

`<EVM>, ...`

The unit depends on `UNIT:EVM`.

The following parameters are supported.

- TRACE1
  Returns the average power for each resource block over all subframes.
- TRACE2
  Returns the minimum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.
- TRACE3
  Returns the maximum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.

9.6.1.14   EVM vs Subframe

For the EVM vs Subframe result display, the command returns one value for each subframe that has been analyzed.

`<EVM>, ...`

The unit depends on `UNIT:EVM`.

The following parameters are supported.

- TRACE1

9.6.1.15   EVM vs Symbol

For the EVM vs Symbol result display, the command returns one value for each OFDM symbol that has been analyzed.

`<EVM>, ...`

For measurements on a single subframe, the command returns the symbols of that subframe only.

The unit depends on `UNIT:EVM`.

The following parameters are supported.

- TRACE1

9.6.1.16   EVM vs Symbol x Carrier

For the EVM vs Symbol x Carrier, the command returns one value for each resource element.

`<EVM[Symbol(0),Carrier(1)]>, ..., <EVM[Symbol(0),Carrier(n)]>,`

`<EVM[Symbol(1),Carrier(1)]>, ..., <EVM[Symbol(1),Carrier(n)]>,`

`...`

`<EVM[Symbol(n),Carrier(1)]>, ..., <EVM[Symbol(n),Carrier(n)]>,`

The unit depends on `UNIT:EVM`.

Resource elements that are unused return `NAN`.

The following parameters are supported.

- TRACE1

9.6.1.17 Frequency Error vs Symbol

For the Frequency Error vs Symbol result display, the command returns one value for each OFDM symbol that has been analyzed.

```
<frequency error>,...
```

The unit is always Hz.

The following parameters are supported.

- TRACE1

9.6.1.18 On/Off Power

For the On/Off Power measurement, the number and type of return values depend on the parameter.

- TRACE1
  Returns the power for the Off power regions.
  ```
  <absolute power>,...
  ```
  The unit is always dBm.
- TRACE2
  Returns the power for the transient regions.
  ```
  <absolute power>,...
  ```
  The unit is always dBm.
- LIST
  Returns the contents of the On/Off Power table. For each line, it returns seven values.
  ```
  <off period start limit>, <off period stop limit>, <time at
  delta to limit>, <absolute off power>, <distance to limit>,
  <falling transient period>, <rising transient period>,...
  ```
  The unit for the `<absolute off power>` is dBm. The unit for the `<distance to limit>` is dB. The unit for the `<transient periods>` is µs. All other values have the unit s.

9.6.1.19 Power Spectrum

For the Power Spectrum result display, the command returns one value for each trace point.

```
<power>,...
```

The unit is always dBm/Hz.

The following parameters are supported.

- TRACE1

9.6.1.20 Power vs RB RS

For the Power vs RB RS result display, the command returns one value for each resource block of the reference signal that has been analyzed.

```
<absolute power>,...
```

The unit is always dBm.

The following parameters are supported.

- TRACE1
  Returns the average power over all subframes
- TRACE2
  Returns the minimum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.
- TRACE3
  Returns the maximum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.

9.6.1.21 Power vs RB PDSCH

For the Power vs RB PDSCH result display, the command returns one value for each resource block of the PDSCH that has been analyzed.

```
<absolute power>,...
```

The unit is always dBm.

The following parameters are supported.

- TRACE1
  Returns the average power over all subframes
- TRACE2
  Returns the minimum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.
- TRACE3
  Returns the maximum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.

9.6.1.22 Power vs Symbol x Carrier

For the Power vs Symbol x Carrier, the command returns one value for each resource element.

```
<P[Symbol(0),Carrier(1)]>, ..., <P[Symbol(0),Carrier(n)]>,

<P[Symbol(1),Carrier(1)]>, ..., <P[Symbol(1),Carrier(n)]>,

...

<P[Symbol(n),Carrier(1)]>, ..., <P[Symbol(n),Carrier(n)]>,
```

with P = Power of a resource element.

The unit is always dBm.

Resource elements that are unused return NAN.

The following parameters are supported.

- TRACE1

9.6.1.23 Spectrum Emission Mask

For the SEM measurement, the number and type of returns values depend on the param-eter.

- TRACE1
  Returns one value for each trace point.
  `<absolute power>, ...`
  The unit is always dBm.
- LIST
  Returns the contents of the SEM table. For every frequency in the spectrum emission mask, it returns nine values.
  `<index>, <start frequency in Hz>, <stop frequency in Hz>, <RBW in Hz>, <limit fail frequency in Hz>, <absolute power in dBm>, <relative power in dBc>, <limit distance in dB>, <limit check result>, ...`
  The `<limit check result>` is either a 0 (for PASS) or a 1 (for FAIL).

9.6.1.24 UE RS Weights Magnitude

For the UE RS Weights Magnitude result display, the command returns one value for each subcarrier that has been analyzed.

`<Magnitude>, ...`

The unit dB.

The following parameters are supported.

- TRACE1
  Returns the magnitude of the measured weights of the reference signal (RS) carriers over one subframe.

9.6.1.25 UE RS Weights Phase

For the UE RS Weights Phase result display, the command returns one value for each subcarrier that has been analyzed.

`<Phase>, ...`

The unit degrees.

The following parameters are supported.

- TRACE1

Returns the phase of the measured weights of the reference signal (RS) carriers over one subframe.

9.6.1.26 Return Value Codes

This chapter contains a list for encoded return values.

<ACK/NACK>

The range is {-1...1}.

- **1** = ACK
- **0** = NACK
- **-1** = DTX

<allocation ID>

Represents the allocation ID. The range is as follows.

- **0 - 65535** = PDSCH
- **-1** = Invalid / not used
- **-2** = All
- **-3** = P-SYNC
- **-4** = S-SYNC
- **-5** = PILOTS_ANT1
- **-6** = PILOTS_ANT2
- **-7** = PILOTS_ANT3
- **-8** = PILOTS_ANT4
- **-9** = PCFICH
- **-10** = PHICH
- **-11** = PDCCH
- **-12** = PBCH
- **-13** = PMCH
- **-14** = Positioning Reference Signal
- **-15** = CSI Reference Signal (Port 15 and 16)
- **-16** = CSI Reference Signal (Port 17 and 18)
- **-17** = CSI Reference Signal (Port 19 and 20)
- **-18** = CSI Reference Signal (Port 21 and 22)
- **-1xxxxx** = UE Reference Signal (Port 5)
- **-2xxxxx** = UE Reference Signal 1 (Port 7, 8, 11, 12)
- **-3xxxxx** = UE Reference Signal 2 (Port 9, 10, 13, 14, signals with more than 2 layers)
  Note. **xxxxx** is a placeholder for the ID of the PDSCH.
  If the PDSCH has, for example, the ID 22, the return value would be -100022, -200022 or -300022 (depending on the configuration)

\<codeword\>

Represents the codeword of an allocation. The range is {0...6}.

- **0** = 1/1
- **1** = 1/2
- **2** = 2/2
- **3** = 1/4
- **4** = 2/4
- **5** = 3/4
- **6** = 4/4

\<DCI format\>

Represents the DCi format. The value is a number in the range {0...103}.

- **0** = DCI format 0
- **10** = DCI format 1
- **11** = DCI format 1A
- **12** = DCI format 1B
- **13** = DCI format 1C
- **14** = DCI format 1D
- **20** = DCI format 2
- **21** = DCI format 2A
- **22** = DCI format 2B
- **23** = DCI format 2C
- **30** = DCI format 3
- **31** = DCI format A
- **103** = DCI format 0/3/3A

\<modulation\>

Represents the modulation scheme. The range is {0...8}.

- **0** = unrecognized
- **1** = RBPSK
- **2** = QPSK
- **3** = 16QAM
- **4** = 64QAM
- **5** = 8PSK
- **6** = PSK
- **7** = mixed modulation
- **8** = BPSK

<number of symbols or bits>

In hexadecimal mode, this represents the number of symbols to be transmitted. In binary mode, it represents the number of bits to be transmitted.

<PHICH duration>

Represents the PHICH duration. The range is {1...2}.

- **1** = normal
- **2** = extended

<PHICH resource>

Represents the parameter N_g. The range is {1...4}.

- **1** = N_g 1/6
- **2** = N_g 1/2
- **3** = N_g 1
- **4** = N_g 2

TRACe[:DATA]? <Result>

This command returns the trace data for the current measurement or result display.

For more information see chapter 9.6.1, "Using the TRACe[:DATA] Command", on page 140.

Query parameters:
<TraceNumber>   **TRACE1 | TRACE2 | TRACE3**

LIST

PBCH

PCFICH

PHICH

PDCCH

Usage: Query only

9.6.2 Reading Out Limit Check Results

9.6.2.1 Checking Limits for Graphical Result Displays

CALCulate<n>:LIMit<k>:ACPower:ACHannel:RESult? <Result>

This command queries the limit check results for the adjacent channels during ACLR measurements.

Query parameters:

<Result>	**ALL** Queries the overall limit check results.
	REL Queries the channel power limit check results.
	ABS Queries the distance to the limit line.

Return values:

<LimitCheck>	Returns two values, one for the upper and one for the lower adjacent channel.
	1 Limit check has passed.
	0 Limit check has failed.

Example:	`CALC:LIM:ACP:ACH:RES? ALL` Queries the results of the adjacent channel limit check.
Usage:	Query only

CALCulate<n>:LIMit<k>:ACPower:ALTernate:RESult? <Result>

This command queries the limit check results for the alternate channels during ACLR measurements.

Query parameters:

<Result>	**ALL** Queries the overall limit check results.
	REL Queries the channel power limit check results.
	ABS Queries the distance to the limit line.

Return values:

<LimitCheck>   Returns two values, one for the upper and one for the lower alter-
                         nate channel.

                         1
                         Limit check has passed.

                         0
                         Limit check has failed.

Example: CALC:LIM:ACP:ALT:RES? ALL
                         Queries the results of the alternate channel limit check.

Usage: Query only

CALCulate<n>:MARKer<m>:FUNCtion:POWer:RESult[:CURRent]?

This command queries the current results of the ACLR measurement or the total signal
power level of the SEM measurement.

To get a valid result, you have to perform a complete measurement with synchronization
to the end of the measurement before reading out the result. This is only possible for
single sweeps.

Suffix:

<m>   1

Query parameters:

CPOW   This parameter queries the signal power of the SEM measure-
                         ment.

Return values:

<Result>   **SEMResults**
                         Power level in dBm.

                         ACLRResults
                         Relative power levels of the ACLR channels. The number of return
                         values depends on the number of transmission and adjacent
                         channels. The order of return values is:
                         • <TXChannelPower> is the power of the transmission channel in
                         dBm
                         • <LowerAdjChannelPower> is the relative power of the lower
                         adjacent channel in dB
                         • <UpperAdjChannelPower> is the relative power of the upper
                         adjacent channel in dB
                         • <1stLowerAltChannelPower> is the relative power of the first
                         lower alternate channel in dB
                         • <1stUpperAltChannelPower> is the relative power of the first
                         lower alternate channel in dB
                         (...)
                         • <nthLowerAltChannelPower> is the relative power of a subse-
                         quent lower alternate channel in dB
                         • <nthUpperAltChannelPower> is the relative power of a subse-
                         quent lower alternate channel in dB

Example: CALC1:MARK:FUNC:POW:RES?

Returns the current ACLR measurement results.

Usage: Query only

CALCulate<n>:LIMit<k>:OOPower:OFFPower?

This command queries the results of the limit check in the "Off" periods of On/Off Power measurements.

Return values:

<OOPResults>   Returns one value for every "Off" period.

1
Limit check has passed.

0
Limit check has failed.

Example: CALC:LIM:OOP:OFFP?

Queries the results for the limit check during the signal Off periods.

Usage: Query only

CALCulate<n>:LIMit<k>:OOPower:TRANsient? <Result>

This command queries the results of the limit check during the transient periods of the On/Off power measurement.

Query parameters:

<Result>   **ALL**
Queries the overall limit check results.

FALLing
Queries the limit check results of falling transients.

RISing
Queries the limit check results of rising transients.

Return values:

<OOPResults>   Returns one value for every "Off" period.

1
Limit check has passed.

0
Limit check has failed.

Example: CALC:LIM:OOP:TRAN? RIS

Queries the limit check of rising transients.

Usage: Query only

9.6.2.2 Checking Limits for Numerical Result Display

CALCulate<n>:LIMit<k>:SUMMary:EVM[:ALL]:MAXimum:RESult
CALCulate<n>:LIMit<k>:SUMMary:EVM[:ALL][:AVERage]:RESult?

This command queries the results of the EVM limit check of all resource elements.

Return values:

<LimitCheck>   The type of limit (average or maximum) that is queried depends
                    on the last syntax element.

                    FAILED
                    Limit check has failed.

                    PASSED
                    Limit check has passed.

                    NOTEVALUATED
                    Limits have not been evaluated.

Example: CALC:LIM:SUMM:EVM:RES?
                    Queries the limit check.

Usage: Query only

CALCulate<n>:LIMit<k>:SUMMary:EVM:DSQP:MAXimum:RESult
CALCulate<n>:LIMit<k>:SUMMary:EVM:DSQP[:AVERage]:RESult?

This command queries the results of the EVM limit check of all PDSCH resource elements
with a QPSK modulation.

Return values:

<LimitCheck>   The type of limit (average or maximum) that is queried depends
                                on the last syntax element.

                                FAILED
                                Limit check has failed.

                                PASSED
                                Limit check has passed.

                                NOTEVALUATED
                                Limits have not been evaluated.

Example: CALC:LIM:SUMM:EVM:DSQP:RES?
                                Queries the limit check.

Usage: Query only

CALCulate<n>:LIMit<k>:SUMMary:EVM:DSSF:MAXimum:RESult
CALCulate<n>:LIMit<k>:SUMMary:EVM:DSSF[:AVERage]:RESult?

This command queries the results of the EVM limit check of all PDSCH resource elements
with a 64QAM modulation.

Return values:

<LimitCheck>   The type of limit (average or maximum) that is queried depends
                                on the last syntax element.

                                FAILED
                                Limit check has failed.

                                PASSED
                                Limit check has passed.

                                NOTEVALUATED
                                Limits have not been evaluated.

Example: CALC:LIM:SUMM:EVM:DSSF:RES?
                                Queries the limit check.

Usage: Query only

CALCulate<n>:LIMit<k>:SUMMary:EVM:DSST:MAXimum:RESult
CALCulate<n>:LIMit<k>:SUMMary:EVM:DSST[:AVERage]:RESult?

This command queries the results of the EVM limit check of all PDSCH resource elements
with a 16QAM modulation.

Return values:

<LimitCheck>   The type of limit (average or maximum) that is queried depends
                                on the last syntax element.

                                FAILED
                                Limit check has failed.

                                PASSED
                                Limit check has passed.

                                NOTEVALUATED
                                Limits have not been evaluated.

Example: CALC:LIM:SUMM:EVM:DSST:RES?
                                Queries the limit check.

Usage: Query only

CALCulate<n>:LIMit<k>:SUMMary:EVM:PCHannel:MAXimum:RESult
CALCulate<n>:LIMit<k>:SUMMary:EVM:PCHannel[:AVERage]:RESult?

This command queries the results of the EVM limit check of all physical channel resource
elements.

Return values:

<LimitCheck>   The type of limit (average or maximum) that is queried depends
                                on the last syntax element.

                                FAILED
                                Limit check has failed.

                                PASSED
                                Limit check has passed.

                                NOTEVALUATED
                                Limits have not been evaluated.

Example: CALC:LIM:SUMM:EVM:PCH:RES?
                                Queries the limit check.

Usage: Query only

CALCulate<n>:LIMit<k>:SUMMary:EVM:PSIGnal:MAXimum:RESult
CALCulate<n>:LIMit<k>:SUMMary:EVM:PSIGnal[:AVERage]:RESult?

This command queries the results of the EVM limit check of all physical signal resource
elements.

Return values:

<LimitCheck>   The type of limit (average or maximum) that is queried depends on the last syntax element.

                    FAILED
                    Limit check has failed.

                    PASSED
                    Limit check has passed.

                    NOTEVALUATED
                    Limits have not been evaluated.

Example: CALC:LIM:SUMM:EVM:PSIG:RES?
                    Queries the limit check.

Usage: Query only

CALCulate<n>:LIMit<k>:SUMMary:FERRor:MAXimum:RESult
CALCulate<n>:LIMit<k>:SUMMary:FERRor[:AVERage]:RESult?

This command queries the result of the frequency error limit check.

Return values:

<LimitCheck>   The type of limit (average or maximum) that is queried depends on the last syntax element.

                    FAILED
                    Limit check has failed.

                    PASSED
                    Limit check has passed.

                    NOTEVALUATED
                    Limits have not been evaluated.

Example: CALC:LIM:SUMM:SERR:RES?
                    Queries the limit check.

Usage: Query only

CALCulate<n>:LIMit<k>:SUMMary:GIMBalance:MAXimum:RESult
CALCulate<n>:LIMit<k>:SUMMary:GIMBalance[:AVERage]:RESult?

This command queries the result of the gain imbalance limit check.

Return values:

<LimitCheck>   The type of limit (average or maximum) that is queried depends on the last syntax element.

                    FAILED
                    Limit check has failed.

                    PASSED
                    Limit check has passed.

                    NOTEVALUATED
                    Limits have not been evaluated.

Example: CALC:LIM:SUMM:GIMB:RES?
                      Queries the limit check.

Usage: Query only

CALCulate<n>:LIMit<k>:SUMMary:IQOFfset:MAXimum:RESult
CALCulate<n>:LIMit<k>:SUMMary:IQOFfset[:AVERage]:RESult?

This command queries the result of the I/Q offset limit check.

Return values:

<LimitCheck>   The type of limit (average or maximum) that is queried depends
                      on the last syntax element.

                      FAILED
                      Limit check has failed.

                      PASSED
                      Limit check has passed.

                      NOTEVALUATED
                      Limits have not been evaluated.

Example: CALC:LIM:SUMM:IQOF:MAX:RES?
                      Queries the limit check.

Usage: Query only

CALCulate<n>:LIMit<k>:SUMMary:QUADerror:MAXimum:RESult
CALCulate<n>:LIMit<k>:SUMMary:QUADerror[:AVERage]:RESult?

This command queries the result of the quadrature error limit check.

Return values:

<LimitCheck>   The type of limit (average or maximum) that is queried depends
                      on the last syntax element.

                      FAILED
                      Limit check has failed.

                      PASSED
                      Limit check has passed.

                      NOTEVALUATED
                      Limits have not been evaluated.

Example: CALC:LIM:SUMM:QUAD:RES?
                      Queries the limit check.

Usage: Query only

CALCulate<n>:LIMit<k>:SUMMary:SERRor:MAXimum:RESult
CALCulate<n>:LIMit<k>:SUMMary:SERRor[:AVERage]:RESult?

This command queries the results of the sampling error limit check.

Return values:

<LimitCheck>   The type of limit (average or maximum) that is queried depends on the last syntax element.

                            FAILED
                            Limit check has failed.

                            PASSED
                            Limit check has passed.

                            NOTEVALUATED
                            Limits have not been evaluated.

Example: `CALC:LIM:SUMM:SERR:RES?`
                       Queries the limit check.

Usage: Query only

9.7   Remote Commands to Configure General Settings

9.7.1   Remote Commands for General Settings

This chapter contains remote control commands necessary to control the general measurement settings.

For more information see chapter 4.1, "Configuring the Measurement", on page 61.

9.7.1.1   Defining General Signal Characteristics

CONFigure[:LTE]:DUPLexing <Duplexing>

This command selects the duplexing mode.

Parameters:

<Duplexing>   **TDD**

Time division duplex

FDD

Frequency division duplex

*RST: FDD

Example: `CONF:DUPL TDD`

Activates time division duplex.

CONFigure[:LTE]:LDIRection <Direction>

This command selects the link direction

Parameters:

<Direction>   **DL**

Downlink

UL

Uplink

Example: `CONF:LDIR DL`

EUTRA/LTE option is configured to analyze downlink signals.

[SENSe]:FREQuency:CENTer[:CC<cci>] <Frequency>

This command sets the center frequency for RF measurements.

Parameters:

<Frequency>   <numeric value>

Range: fmin to fmax

*RST: 1 GHz

Default unit: Hz

Example: `FREQ:CENT 2GHZ`

Set the center frequency to 2 GHz.

9.7.1.2 Selecting the Input Source

SENSe:INPut <Source>

This command selects the signal source.

Parameters:

<Source>   **RF**
                            Select radio frequency input as signal source.

                            AIQ
                            Select analog I/Q input (baseband) as signal source.

                            DIQ
                            Select digital I/Q input as signal source.

Example: INP DIQ
                            Select digital I/Q as signal source.

9.7.1.3   Configuring the Input Level

[SENSe]:POWer:AUTO<analyzer>[:STATe] <State>

This command initiates a measurement that determines the ideal reference level.

Parameters:

<State>   **OFF**
                            Performs no automatic reference level detection.

                            ON
                            Performs an automatic reference level detection before each mea-
                            surement.

                            ONCE
                            Performs an automatic reference level once.

                            *RST: ON

Example: POW:AUTO2 ON
                            Activate auto level for analyzer number 2.

CONFigure:POWer:EXPected:RF<analyzer> <RefLevel>

This command defines the reference level when the input source is RF.

Parameters:

<RefLevel>   *RST: -30 dBm
                            Default unit: DBM

Example: CONF:POW:EXP:RF3 -20
                            Sets the radio frequency reference level used by analyzer 3 to -20
                            dBm.

CONFigure:POWer:EXPected:IQ<analyzer> <RefLevel>

This command defines the reference level when the input source is baseband.

Parameters:

<RefLevel>   <numeric value>

Range: 31.6 mV to 5.62 V
*RST: 1 V
Default unit: V

Example: CONF:POW:EXP:IQ2 3.61
Sets the baseband-reference level used by analyzer 2 to 3.61 V.

INPut<n>:ATTenuation<analyzer> <Attenuation>

This command sets the RF attenuation level.

Parameters:

<Attenuation>   <numeric value>

*RST: 5 dB
Default unit: dB

Example: INP:ATT 10
Defines an RF attenuation of 10 dB.

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet <Attenuation>

This command selects the external attenuation or gain applied to the RF signal.

Parameters:

<Attenuation>   <numeric value>

*RST: 0
Default unit: dB

Example: DISP:TRAC:Y:RLEV:OFFS 10
Sets an external attenuation of 10 dB.

9.7.1.4 Configuring the Data Capture

[SENSe]:SWEep:TIME <CaptLength>

This command sets the capture time.

Parameters:

<CaptLength>   Numeric value in seconds.

Default unit: s

Example: SWE:TIME 40

Defines a capture time of 40 seconds.

[SENSe][:LTE]:FRAMe:COUNt:STATe <State>

This command turns manual selection of the number of frames you want to analyze on and off.

Parameters:

<State>   **ON**

You can set the number of frames to analyze.

OFF

The software analyzes a single sweep.

*RST: ON

Example: FRAM:COUN:STAT ON

Turns manual setting of number of frames to analyze on.

[SENSe][:LTE]:FRAMe:COUNt <Subframes>

This command sets the number of frames you want to analyze.

Parameters:

<Subframes>   <numeric value>

*RST: 1

Example: FRAM:COUN:STAT ON

Activates manual input of frames to be analyzed.

FRAM:COUN 20

Analyzes 20 frames.

[SENSe][:LTE]:FRAMe:COUNt:AUTO <State>

This command turns automatic selection of the number of frames to analyze on and off.

Parameters:

<State>   **ON**

Selects the number of frames to analyze according to the LTE standard.

OFF

Turns manual selection of the frame number on.

Example: FRAM:COUN:AUTO ON

Turns automatic selection of the analyzed frames on.

9.7.1.5 Configuring Measurement Results

UNIT:EVM <Unit>

This command selects the EVM unit.

Parameters:

<Unit>   **DB**
                          EVM results returned in dB

                          PCT
                          EVM results returned in %

                          *RST: PCT

Example: UNIT:EVM PCT
                          EVM results to be returned in %.

UNIT:BSTR <Unit>

This command selects the way the bit stream is displayed.

Parameters:

<Unit>   **SYMbols**
                          Displays the bit stream using symbols

                          BITs
                          Displays the bit stream using bits

                          *RST: SYMbols

Example: UNIT:BSTR BIT
                          Bit stream gets displayed using Bits.

UNIT:CAXes <Unit>

This command selects the scale of the x-axis for result displays that show subcarrier results.

Parameters:

<Unit>   **CARR**
                          Shows the number of the subcarriers on the x-axis.

                          HZ
                          Shows the frequency of the subcarriers on the x-axis.

Example: UNIT:CAX HZ
                          Selects frequency scale for the x-axis.

[SENSe][:LTE]:ANTenna:SELect <Antenna>

This command selects the antenna for which the results are shown.

Available if the number of input channels is "From Antenna Selection".

Parameters:

<Antenna>   Number of the antenna.

                         1 | 2 | 3 | 4
                         Number of the antenna.

                         ALL
                         Shows the results for all antennas.

                         *RST: 1

Example: `SENS:ANT:SEL 2`
                         Selects antenna 2.

[SENSe][:LTE]:SOURce:SELect <Source>

This command selects the antenna (ports) the results are displayed for.

Parameters:

<Source>   **ALL**
                         Shows the results for all I/Q data streams in the result display.

                         <numeric value>
                         Selects one I/Q data stream to display the results for. The range depends on the number of input channels you are using.

Example: `SOUR:SEL 4`
                         Shows the results for the 4th I/Q data stream.

[SENSe][:LTE]:SUBFrame:SELect <Subframe>

This command selects the subframe to be analyzed.

Parameters:

<Subframe>   ALL | <numeric value>

                         ALL
                         Select all subframes

                         0...39
                         Select a single subframe

                         *RST: ALL

Example: `SUBF:SEL ALL`
                         Select all subframes for analysis.

9.7.1.6   Configuring Time Alignment Measurements

Remote commands to configure Time Alignment measurements described elsewhere:

- `[SENSe]:FREQuency:CENTer[:CC<cci>]` on page 164
  Demod settings for CC2: chapter 9.8, "Remote Command to Configure the Demodulation", on page 179

CONFigure:NOCC <Carriers>

This command selects the number of component carriers evaluated in the Time Alignment measurement.

Parameters:

<Carriers>   1 | 2

                      *RST: 1

Example: CONF:NOCC 2

                      Selects 2 carriers.

9.7.1.7 Configuring On/Off Power Measurements

[SENSe][:LTE]:OOPower:CAGGregation <NoiseCorrection>

This command turns carrier aggregation for Transmit On/Off Power measurements on and off.

Parameters:

<NoiseCorrection>   ON | OFF

                      *RST: OFF

Example: FREQ:CENT 1GHZ

                      Defines a center for the master component carrier of 1 GHz.

                      OOP:CAGG ON

                      OOP:FREQ:LOW 950MHZ

                      OOP:FREQ:HIGH 1050MHZ

                      Turns on carrier aggregation and defines a frequency band between 950 MHz and 1.05 GHz.

[SENSe][:LTE]:OOPower:FREQuency:HIGHer <Frequency>

This command defines the higher edge frequency for Transmit On/Off Power measurements with carrier aggregation.

Parameters:

<Frequency>   <numeric value>

                      Default unit: Hz

Example: See [SENSe][:LTE]:OOPower:CAGGregation.

[SENSe][:LTE]:OOPower:FREQuency:LOWer <Frequency>

This command defines the lower edge frequency for Transmit On/Off Power measurements with carrier aggregation.

Parameters:

<Frequency>   <numeric value>

                            Default unit: Hz

Example: See [SENSe][:LTE]:OOPower:CAGGregation.

[SENSe][:LTE]:OOPower:NCORrection <NoiseCorrection>

This command turns noise correction for On/Off Power measurements on and off.

Parameters:

<NoiseCorrection>   ON | OFF

CONFigure[:LTE]:OOPower:NFRames <Frames>

This command defines the number of frames that are analyzed for On/Off Power measurements.

Parameters:

<Frames>   <numeric value>

Example: CONF:OOP:NFR 10
                            Defines 10 frames to be analyzed.

9.7.2 Configuring MIMO Measurement Setups

Commands useful to configure MIMO setups described elsewhere:

- CONFigure[:LTE]:DL[:CC<cci>]:MIMO:ASELection on page 187

- CONFigure[:LTE]:DL[:CC<cci>]:MIMO:CONFig on page 187

CONFigure:ACONfig<analyzer>:ADDRess <Address>

This command defines the network address of an analyzer or oscilloscope in the test setup.

Parameters:

<Address>   String containing the address of the analyzer.

Connections are possible via TCP/IP or GPIB. Depending on the type of connection, the string has the following syntax.

`'GPIB[board]::<PrimaryAddress>[:: <SecondaryAddress>][::INSTR]'`

`'TCPIP[board]::<HostAddress>[:: <LANDeviceName>][::INSTR]'`

Elements in square brackets are optional.

Example: `CONF:ACON:ADDR 'TCPIP::192.168.0.1'`

Defines a TCP/IP connection for the first analyzer in the test setup.

`CONF:ACON:ADDR 'GPIB::28'`

Defines a GPIB connection for the first analyzer in the test setup.

CONFigure:ACONfig<analyzer>:ICSequence <ICSequence>

This command defines the sequence in which the oscilloscope channels are accessed.

Parameters:

<ICSequence>   String containing a sequence of four numbers between 1 and 4. Each number represents an input channel.

Example: `CONF:ACON:ICS '1,3,2,4'`

Defines the sequence for an oscilloscope with four channels. The channels are subsequently accessed in the order 1 ➜ 3 ➜ 2 ➜ 4.

CONFigure:ACONfig<analyzer>:NCHannels <NCHannels>

This command defines the number of oscilloscope channels you want to use.

Parameters:

<NCHannels>   1 | 2 | 3 | 4

The maximum number you can select depends on the number of channels of the oscilloscope you are using.

Example: `CONF:ACON:NCH 2`

Defines a measurement on 2 channels.

CONFigure[:LTE]:NSOurces <Channels>

This command selects the number of input channels you are using to capture several streams of I/Q data.

Parameters:

<Channels>   **1 | 2 | 4 | 8**

ASEL

Number of channels is the same as the number of Tx antennas in the test setup (`CONFigure[:LTE]:DL[:CC<cci>]:MIMO: CONFig`).

Example: CONF:NSO 4
Selects four input channels.

9.7.3 Using a Trigger

TRIGger[:SEQuence]:MODE <Source>

This command selects the trigger source.

Parameters:
<Source>   **EXTernal**
                      Selects external trigger source.

                      IMMediate
                      Selects free run trigger source.

                      POWer
                      Selects IF power trigger source.

                      TUNit
                      Selects the trigger unit R&S FS-Z11 as the trigger source.

                      *RST: IMMediate
Example: TRIG:MODE EXT
                      Selects an external trigger source.

TRIGger[:SEQuence]:HOLDoff<analyzer> <Offset>

This command defines the trigger offset.

Parameters:
<Offset>   <numeric value>
                      *RST: 0 s
                      Default unit: s
Example: TRIG:HOLD 5MS
                      Sets the trigger offset to 5 ms.

TRIGger[:SEQuence]:LEVel<analyzer>[:EXTernal] <Level>

This command defines the level for an external trigger.

Parameters:

<Level>	Range:	0.5 V to 3.5 V
	*RST:	1.4 V
	Default unit: V	

Example: TRIG:LEV 2V
Defines a trigger level of 2 V.

TRIGger[:SEQuence]:LEVel<analyzer>:POWer <Level>

This command defines the trigger level for an IF power trigger.

Parameters:

<Level>   Default unit: DBM

Example: TRIG:LEV:POW 10
Defines a trigger level of 10 dBm.

TRIGger[:SEQuence]:PORT<analyzer> <Port>

This command selects the trigger port for measurements with devices that have several trigger ports (e.g. the R&S FSW).

Parameters:

<Port>   **PORT1**

                         PORT2

                         PORT3

Example: TRIG:PORT PORT1
Selects trigger port 1.

TRIGger[:SEQuence]:SLOPe <Slope>

This command selects the trigger slope.

Parameters:

<Slope>   **POSitive**
Triggers a measurement when the signal rises to the trigger level.
NEGative
Triggers a measurement when the signal falls to the trigger level.

Example: TRIG:SLOP POS
Selects a positive trigger slope.

9.7.4 Configuring Spectrum Measurements

9.7.4.1 Configuring SEM and ACLR Measurements

[SENSe]:POWer:SEM:CATegory <Category>

This command selects the SEM limit category as defined in 3GPP TS 36.104.

Parameters:

<Category>
                A
                Category A (Wide Area base station)

                B1
                Category B Opt 1 (Wide Area base station)

                B2
                Category B Opt 2 (Wide Area base station)

                HOME
                Home base station

                LARE
                Local Area base station

                *RST: A

Example:
                `POW:SEM:CAT B`
                Selects SEM category B.

[SENSe]:POWer:ACHannel:AACHannel <Channel>

This command selects the assumed adjacent channel carrier for ACLR measurements.

Parameters:

<Channel>
                EUTRA
                Selects an EUTRA signal of the same bandwidth like the TX chan-
                nel as assumed adjacent channel carrier.

                UTRA128
                Selects an UTRA signal with a bandwidth of 1.28MHz as assumed
                adjacent channel carrier.

                UTRA384
                Selects an UTRA signal with a bandwidth of 3.84MHz as assumed
                adjacent channel carrier.

                UTRA768
                Selects an UTRA signal with a bandwidth of 7.68MHz as assumed
                adjacent channel carrier.

                *RST: EUTRA

Example:
                `POW:ACH:AACH UTRA384`
                Selects an UTRA signal with a bandwidth of 3.84MHz as assumed
                adjacent channel carrier.

[SENSe]:POWer:NCORrection <State>

This command turns noise correction for ACLR measurements on and off.

Parameters:

<State>	ON | OFF
	*RST: OFF

Example:	POW:NCOR ON
	Activates noise correction.

[SENSe]:SWEep:EGATe:AUTO <State>

This command turns auto gating for SEM and ACLR measurements on and off.

This command is available for TDD measurements in combination with an external or IF power trigger.

Parameters:

<State>	**ON**
	Evaluates the on-period of the LTE signal only.
	OFF
	Evaluates the complete signal.

Example:	SWE:EGAT:AUTO ON
	Turns auto gating on.

9.7.5 Remote Commands for Advanced Settings

This chapter contains all remote control commands to control the advanced settings.

For more information on advanced settings see chapter 4.5, "Advanced Settings", on page 76.

9.7.5.1 Controlling I/Q Data

[SENSe]:SWAPiq <State>

This command turns a swap of the I and Q branches on and off.

Parameters:

<State>	ON | OFF
	*RST: OFF

Example: SWAP ON

Turns a swap of the I and Q branches on.

9.7.5.2   Configuring the Baseband Input

INPut:IQ:IMPedance <Impedance>

This command selects the input impedance for I/Q inputs.

Parameters:

<Impedance>   LOW | HIGH

*RST: LOW

Example: INP:IQ:IMP LOW

Selects low input impedance for I/Q input.

INPut:IQ:BALanced[:STATe] <State>

This command selects if the I/Q inputs are symmetrical (balanced) or asymmetrical (unbalanced)

Parameters:

<State>   ON | OFF

*RST: ON

Example: INP:IQ:BAL ON

Specifies symmetrical (balanced) IQ inputs.

[SENSe]:IQ:LPASs[:STATe] <State>

This command turns a baseband input lowpass filter on and off.

Parameters:

<State>   ON | OFF

*RST: ON

Example: IQ:LPAS ON

Activate the input lowpass.

[SENSe]:IQ:DITHer[:STATe] <State>

This command adds or removes a noise signal into the signal path (dithering).

Parameters:

<State>	ON | OFF
	*RST: OFF

Example: `IQ:DITH ON`
Activate input dithering.

9.7.5.3 Using Advanced Input Settings

[SENSe]:POWer:AUTO<analyzer>:TIME <Time>

This command defines the track time for the auto level process.

Parameters:

<Time>	<numeric value>
	*RST: 100 ms
	Default unit: s

Example: `POW:AUTO:TIME 200ms`
An auto level track time of 200 ms gets set.

9.7.5.4 Configuring the Digital I/Q Input

The digital I/Q input is available with option R&S FSQ-B17 or R&S FSV-B17.

INPut<n>:DIQ:RANGe[:UPPer] <ScaleLevel>

This command defines the full scale level for a digital I/Q signal source.

Parameters:

<ScaleLevel>	*RST: 1 V
	Default unit: V

Example: `INP:DIQ:RANG 0.7`
Sets the full scale level to 0.7 V.

INPut<n>:DIQ:SRATe <SampleRate>

This command defines the sampling rate for a digital I/Q signal source.

Parameters:

<SampleRate>	*RST: 10 MHz
	Default unit: Hz

Example: `INP:DIQ:SRAT 10MHZ`
Defines a sampling rate of 10 MHz.

9.7.5.5   Configuring Home Base Stations

[SENSe]:POWer:SEM:CHBS:AMPower <Power>

This command defines the aggregated maximum power for home base stations.

Parameters:

<Power>   Numeric value that defines the maximum aggregate power.

                             Default unit: dBm

Example: POW:SEM:CHBS:AMP 0

                             Defines a power of 0 dBm.

9.8   Remote Command to Configure the Demodulation

Configuring component carriers

If you want to configure the second component carrier (CC2), make sure to include the **[:CC2]** part of the syntax.

Example: CONF:DL:CC2:BW 10

9.8.1   Remote Commands for PDSCH Demodulation Settings

This chapter contains remote commands necessary to define PDSCH demodulation.

For more information see chapter 5.1, "Configuring Downlink Signal Demodulation", on page 81.

9.8.1.1   Selecting the Demodulation Method

[SENSe][:LTE]:DL:DEMod:AUTO <State>

This command turns automatic demodulation for downlink signals on and off.

Parameters:

<State>   ON | OFF

                           *RST: ON

Example: `DL:DEM:AUTO ON`

                           Activates the auto-demodulation for DL.

[SENSe][:LTE]:DL:FORMat:PSCD <Format>

This command selects the method of identifying the PDSCH resource allocation.

Parameters:

<Format>   **OFF**
                           Applies the user configuration of the PDSCH subframe regardless
                           of the signal characteristics.

                           PDCCH
                           Identifies the configuration according to the data in the PDCCH
                           DCIs.

                           PHYDET
                           Manual PDSCH configuration: analysis only if the actual subframe
                           configuration matches the configured one.
                           Automatic PDSCH configuration: physical detection of the config-
                           uration.

                           *RST: PHYD

Example: `DL:FORM:PSCD OFF`

                           Applies the user configuration and does not check the received
                           signal

9.8.1.2 Configuring Multicarrier Base Stations

[SENSe][:LTE]:DL:DEMod:MCFilter <State>

This command turns suppression of interfering neighboring carriers on and off (e.g. LTE,
WCDMA, GSM etc).

Parameters:

<State>   ON | OFF

                           *RST: OFF

Example: `DL:DEM:MCF ON`

                           Turns suppression on of neighboring carriers on.

9.8.1.3 Configuring Parameter Estimation

[SENSe][:LTE]:DL:DEMod:BESTimation <State>

This command turns boosting estimation for downlink signals on and off.

Parameters:

<State>   ON | OFF

                    *RST: ON

Example: `DL:DEM:BEST ON`

                    Turns boosting estimation on.

[SENSe][:LTE]:DL:DEMod:CESTimation <Type>

This command selects the channel estimation type for downlink signals.

Parameters:

<Type>   **TGPP**
                    3GPP EVM definition

                    PIL
                    Optimal, pilot only

                    PILP
                    Optimal, pilot and payload

                    *RST: TGPP

Example: `DL:DEM:CEST TGPP`

                    Use 3GPP EVM definition for channel estimation.

9.8.1.4 Compensating Measurement Errors

[SENSe][:LTE]:DL:TRACking:PHASe <Type>

This command selects the phase tracking type for downlink signals.

Parameters:

<Type>   **OFF**
                    Deactivate phase tracking

                    PIL
                    Pilot only

                    PILP
                    Pilot and payload

                    *RST: OFF

Example: DL:TRAC:PHAS PILPAY
Use pilots and payload for phase tracking.

[SENSe][:LTE]:DL:TRACking:TIME <State>

This command turns timing tracking for downlink signals on and off.

Parameters:

<State>   ON | OFF

                     *RST: OFF

Example: DL:TRAC:TIME ON
Activates timing tracking.

9.8.1.5 Configuring EVM Measurements

[SENSe][:LTE]:DL:DEMod:EVMCalc <Calculation>

This command selects the EVM calculation method for downlink signals.

Parameters:

<Calculation>   **TGPP**
3GPP definition

                     OTP
Optimal timing position

                     *RST: TGPP

Example: DL:DEM:EVMC TGPP
Use 3GPP method.

[SENSe][:LTE]:DL:DEMod:PRData <Reference>

This command the type of reference data to calculate the EVM for the PDSCH.

Parameters:

<Reference>   **AUTO**
Automatic identification of reference data.

                     ALL0
Reference data is 0, according to the test model definition.

Example: DL:DEM:PRD ALL0
Sets the reference data of the PDSCH to 0.

9.8.1.6 Processing Demodulated Data

[SENSe][:LTE]:DL:DEMod:CBSCrambling <State>

This command turns scrambling of coded bits for downlink signals on and off.

Parameters:

<State>   ON | OFF

                             *RST: ON

Example: DL:DEM:CBSC ON

                             Activate scrambling of coded bits.

[SENSe][:LTE]:DL:DEMod:DACHannels <State>

This command turns the decoding of all control channels on and off.

Parameters:

<State>   ON | OFF

                             *RST: OFF

Example: DL:DEM:DACH ON

                             Turns decoding of all control channels on.

9.8.1.7 Configuring MIMO Setups

CONFigure[:LTE]:DL:MIMO:CROSstalk <State>

This command turns MIMO crosstalk compensation on and off.

Parameters:

<State>   ON | OFF

                             *RST: OFF

Example: CONF:DL:MIMO:CROS ON

                             Turns crosstalk compensation on.

9.8.2 Remote Commands for DL Signal Characteristics

This chapter contains remote commands necessary to define downlink signal characteristics.

For more information see chapter 5.2, "Defining Downlink Signal Characteristics", on page 87.

9.8.2.1 Defining the Physical Signal Characteristics

CONFigure[:LTE]:DL[:CC<cci>]:BW <Bandwidth>

This command selects the downlink bandwidth.

Parameters:

<Bandwidth>   BW1_40 | BW3_00 | BW5_00 | BW10_00 | BW15_00 |
                    BW20_00

                    *RST: BW10_00

Example: CONF:NOCC 2
                    CONF:DL:CC1:BW BW10_00
                    CONF:DL:CC2:BW BW10_00
                    Selects two carriers, both with a bandwidth of 10 MHz.

CONFigure[:LTE]:DL[:CC<cci>]:CYCPrefix <PrefixLength>

This command selects the cyclic prefix for downlink signals.

Parameters:

<PrefixLength>   **NORM**
                    Normal cyclic prefix length

                    EXT
                    Extended cyclic prefix length

                    AUTO
                    Automatic cyclic prefix length detection

                    *RST: AUTO

Example: CONF:DL:CYCP EXT
                    Sets cyclic prefix type to extended.

CONFigure[:LTE]:DL[:CC<cci>]:TDD:UDConf <Configuration>

This command selects the UL/DL subframe configuration for downlink signals.

Parameters:

<Configuration>   Range: 0 to 6
                    *RST: 0

Example: CONF:DL:TDD:UDC 2
                    Selects allocation configuration number 2.

CONFigure[:LTE]:DL[:CC<cci>]:TDD:SPSC <Configuration>

Selects the configuration of a TDD special subframe.

Parameters:

<Configuration>   <numeric value>

Numeric value that defines the subframe configuration.
Subframe configurations 7 and 8 are only available if the cyclic prefix is normal.

Range: 0 to 8
*RST: 0

Example: `CONF:DL:CYCP NORM`

Selects normal cyclic prefix.

`CONF:DL:TDD:SPSC 7`

Selects subframe configuration 7, available only with a normal cyclic prefix.

FETCh[:CC<cci>]:CYCPrefix?

This command queries the cyclic prefix type that has been detected.

Return values:

<PrefixType>   The command returns -1 if no valid result has been detected yet.

NORM
Normal cyclic prefix length detected

EXT
Extended cyclic prefix length detected

Example: `FETC:CYCP?`

Returns the current cyclic prefix length type.

Usage: Query only

9.8.2.2   Configuring the Physical Layer Cell Identity

CONFigure[:LTE]:DL[:CC<cci>]:PLC:CID <CellId>

This command defines the cell ID.

Parameters:

<CellId>   **AUTO**
                  Automatically defines the cell ID.

                  <numeric value>
                  Number of the cell ID.

                  Range: 0 to 503

Example: CONF:NOCC 2
                  CONF:DL:CC1:PLC:CID 12
                  CONF:DL:CC2:PLC:CID 15
                  Selects 2 carriers and defines a cell ID for each one.

CONFigure[:LTE]:DL[:CC<cci>]:PLC:CIDGroup <GroupNumber>

This command selects the cell ID group for downlink signals.

Parameters:

<GroupNumber>   **AUTO**
                  Automatic selection

                  0...167
                  Manual selection

                  *RST: AUTO

Example: CONF:DL:PLC:CIDG 134
                  Cell identity group number 134 is selected
                  CONF:DL:PLC:CIDG AUTO
                  Automatic cell identity group detection is selected

---

CONFigure[:LTE]:DL[:CC<cci>]:PLC:PLID <Identity>

This command defines the physical layer cell identity for ownlink signals.

Parameters:

<Identity>   **AUTO**
                  Automatic selection

                  0...2
                  Manual selection

                  *RST: AUTO

Example: CONF:DL:PLC:PLID 1
                  Selects physical layer cell ID 2.

FETCh[:CC<cci>]:PLC:CIDGroup?

This command queries the cell identity group that has been detected.

Return values:

<CidGroup>   The command returns -1 if no valid result has been detected yet.

                  Range: 0 to 167

Example:	`FETC:PLC:CIDG?`
	Returns the current cell identity group.
Usage:	Query only

FETCh[:CC<cci>]:PLC:PLID?

This command queries the cell identity that has been detected.

Return values:

<Identity>	The command returns -1 if no valid result has been detected yet.
	Range: 0 to 2
Example:	`FETC:PLC:PLID?`
	Returns the current cell identity.
Usage:	Query only

9.8.2.3 Configuring MIMO Setups

CONFigure[:LTE]:DL[:CC<cci>]:MIMO:ASELection <Antenna>

This command selects the antenna for measurements with MIMO setups.

In case of Time Alignment measurements, the command selects the reference antenna.

Parameters:

<Antenna>	**ANT1	ANT2	ANT3	ANT4**
	Select a single antenna to be analyzed
	ALL
	Select all antennas to be analyzed
	**AUT1	AUT2	AUT4**
	Automatically selects the antenna(s) to be analyzed.
	AUT1 tests a single antenna, AUT2 tests two antennas, AUT4 tests four antennas.
	Available if the number of input channels is taken "From Antenna Selection".
	AUTO
	Automatically selects the antenna(s) to be analyzed.
	*RST: ANT1

CONFigure[:LTE]:DL[:CC<cci>]:MIMO:CONFig <NofAntennas>

This command sets the number of antennas in the MIMO setup.

Parameters:

<NofAntennas>   **TX1**
                       Use one Tx-antenna

                       TX2
                       Use two Tx-antennas

                       TX4
                       Use four Tx-antennas

                       *RST: TX1

Example: CONF:DL:MIMO:CONF TX2
                       TX configuration with two antennas is selected.

9.8.2.4   Configuring PDSCH Subframes

CONFigure[:LTE]:DL:CSUBframes <NofSubframes>

This command selects the number of configurable subframes in the downlink signal.

Parameters:

<NofSubframes>   Range: 0 to 39
                      *RST: 1

Example: CONF:DL:CSUB 5
                      Sets the number of configurable subframes to 5.

CONFigure[:LTE]:DL:SUBFrame<subframe>:ALCount <NofAllocations>

This command defines the number of allocations in a downlink subframe.

Parameters:

<NofAllocations>   <numeric value>

                      *RST: 1

Example: CONF:DL:SUBF2:ALC 5

Defines 5 allocations for subframe 2.

CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:GAP <VRBGap>

This command turns the VRB Gap on and off.

Parameters:

<VRBGap>   **0**

Selects localized VRBs

1

Selects distributed VRBs and applies the first gap

2

Selects distributed VRBs and applies the second gap (for channel bandwidths > 50 resource blocks)

*RST: 0

Example:

CONF:DL:SUBF2:ALL5:GAP 0

Selects localized VRBs for allocation 5 in subframe 2.

CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:UEID <ID>

This command defines the ID or N_RNTI.

Parameters:

<ID>   ID of the user equipment.

Example: CONF:DL:SUBF2:ALL5:UEID 5

Assigns the ID 5 to allocation 5 in subframe 2.

CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>[:CW<Cwnum>]: MODulation <Modulation>

This command selects the modulation of an allocation in a downlink subframe.

Suffix:

<Cwnum>   1..n

Selects the codeword.

Parameters:

<Modulation>   **QPSK**

QPSK modulation

QAM16

16QAM modulation

QAM64

64QAM modulation

*RST: QPSK

Example: CONF:DL:SUBF2:ALL5:CW2:MOD QAM64

Selects a 64QAM modulation for the second codeword of alloca-
tion 5 in subframe 2.

CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:POWer <Power>

This command defines the (relative) power of an allocation in a downlink subframe.

Parameters:

<Power>   <numeric value>

*RST: 0 dB
Default unit: DB

Example: CONF:DL:SUBF2:ALL5:POW -1.3

Defines a relative power of 1.3 dB for allocation 5 in subframe 2.

CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:PRECoding:AP
   <Port>

This command selects the antenna port for the beamforming scheme.

The command is available if the codeword to layer mapping is 1/1.

Parameters:

<Port>   5 | 7 | 8

Example: CONF:DL:SUBF2:ALL3:PREC:AP 5

Selects antenna port 5 for beamforming in allocation 3 in subframe
2.

CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:PRECoding:
   CBINdex <CBIndex>

This command selects the codebook index for an allocation with spatial multiplexing pre-
coding scheme.

Parameters:

<CBIndex>   0...15

*RST: 1

Example: CONF:DL:SUBF2:ALL4:PREC:CBIN 3

Selects codebook index 3 for allocation 4 in subframe number 2.

CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:PRECoding:
   CLMapping <Mapping>

This command selects the codeword to layer mapping.

Parameters:

<Mapping>   LC11 | LC21 | LC31 | LC41 | LC22 | LC32 | LC42 | LC52 | LC62 |
                        LC72 | LC82

Example: CONF:DL:SUBF2:ALL3:PREC:CLM LC11

Assigns codeword-to-layer mapping 1/1 to allocation 3 in sub-frame 2.

CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:PRECoding: CDD <State>

This command turns the cyclic delay diversity of an allocation with spatial multiplexing precoding scheme on and off.

Parameters:

<State> ON | OFF

*RST: OFF

Example: CONF:DL:SUBF2:ALL3:PREC:CDD ON

Turns the cylic delay diversity for allocation 3 in subframe 2 on.

CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:PRECoding[: SCHeme] <Scheme>

This command selects the precoding scheme of an allocation.

Parameters:

<Scheme> **NONE**
Do not use a precoding scheme.

BF
Use beamforming scheme.

SPM
Use spatial multiplexing scheme.

TXD
Use transmit diversity scheme.

*RST: NONE

Example: CONF:DL:SUBF2:ALL3:PREC:SCH SPM

Selects the spatial multiplexing precoding scheme for allocation 3 in subframe 2.

CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:PRECoding: SCID <ID>

This command selects the scrambling identity (nSCID).

The command is available for antenna ports 7 and 8.

Parameters:

<ID> 0 | 1

Example: CONF:DL:SUBF2:ALL4:PREC:SCID 1

Selects scrambling identity 1 for allocation 4 in subframe 2.

CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:PSOFfset
    <PSOFfset>

This command defines the PDSCH start offset for a particular PDSCH allocation.

Parameters:

<PSOFfset>   **<numeric value>**
                            Number between 0 and 4.

                            COMM
                            Common PDSCH start offset.

Example: CONF:DL:SUBF2:ALL2:PSOF 0
                            Defines a PDSCH start offset of 0 for the 2nd allocation in the 2nd
                            subframe.

CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:RBCount
    <ResourceBlocks>

This command selects the number of resource blocks of an allocation in a downlink sub-
frame.

Parameters:

<ResourceBlocks>   <numeric value>
                            *RST: 6

Example: CONF:DL:SUBF2:ALL5:RBC 25
                            Defines 25 resource block for allocation 5 in subframe 2.

CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:RBOFfset
    <Offset>

This command defines the resource block offset of an allocation in a downlink subframe.

Parameters:

<Offset>   <numeric value>
                            *RST: 0

Example: CONF:DL:SUBF2:ALL5:RBOF 3
                            Defines a resource block offset of 3 for allocation 5 in subframe 2.

9.8.3 Remote Commands for DL Advanced Signal Characteristics

This chapter contains remote commands necessary to define advanced downlink signal
characteristics.

For more information see chapter 5.3, "Defining Advanced Signal Characteristics",
on page 95.

9.8.3.1 Configuring the Synchronization Signal

CONFigure[:LTE]:DL[:CC<cci>]:SYNC:ANTenna <Antenna>

This command selects the antenna that transmits the P-SYNC and the S-SYNC.

Parameters:

<Antenna>   ANT1 | ANT2 | ANT3 | ANT4 | ALL | NONE

                   *RST: ALL

Example: CONF:DL:SYNC:ANT ALL

                   All antennas are used to transmit the P-SYNC and S-SYNC.

CONFigure[:LTE]:DL:SYNC:PPOWer <Power>

This command defines the relative power of the P-SYNC.

Parameters:

<Power>   <numeric value>

                   *RST: 0 dB
                   Default unit: DB

Example: CONF:DL:SYNC:PPOW 0.5

                   Sets a relative power of 0.5 dB.

CONFigure[:LTE]:DL:SYNC:SPOWer <Power>

This command defines the relative power of the S-SYNC.

Parameters:

<Power>   <numeric value>

                   *RST: 0 dB
                   Default unit: DB

Example: CONF:DL:SYNC:SPOW 0.5

                   Sets a relative power of 0.5 dB.

9.8.3.2 Configuring the Reference Signal

CONFigure[:LTE]:DL:REFSig:POWer <Power>

This command defines the relative power of the reference signal.

Parameters:

<Power>   <numeric value>

                         *RST: 0 dB
                         Default unit: DB

Example: CONF:DL:REFS:POW -1.2
                         Sets a relative power of -1.2 dB.

9.8.3.3 Configuring the Positioning Reference Signal

CONFigure[:LTE]:DL:PRSS:STATe <State>

This command turns the positioning reference signal on and off.

Parameters:

<State>   ON | OFF

Example: CONF:DL:PRSS:STAT ON
                         Turns the positioning reference signal on.

CONFigure[:LTE]:DL:PRSS:BW <Bandwidth>

This command defines the bandwidth of the positioning reference signal.

Parameters:

<Bandwidth>   BW1_40 | BW3_00 | BW5_00 | BW10_00 | BW15_00 |
                         BW20_00

                         *RST: BW1_40
                         Default unit: MHz

Example: CONF:DL:PRSS:BW BW5_00
                         Defines a 5 MHz bandwidth for the positiong reference signal.

CONFigure[:LTE]:DL:PRSS:CI <PRSConfiguration>

This command selects the configuration index of the Positioning Reference Signal.

Parameters:

<PRSConfiguration> Number of the configuration index.

Example: CONF:DL:PRSS:CI 2

                      Selects configuration index 2 for the positioning reference signal.

CONFigure[:LTE]:DL:PRSS:NPRS <NofDLSubframes>

This command defines the number of subframes the Positioning Reference Signal occupies.

Parameters:

<NofDLSubframes>   1 | 2 | 4 | 6

Example: CONF:DL:PRSS:NPRS 1

                      Defines 1 subframe for the poitioning reference signal.

CONFigure[:LTE]:DL:PRSS:POWer <Power>

This command defines the relative power of the Positioning Reference Signal.

Parameters:

<Power>   Default unit: dB

Example: CONF:DL:PRSS:POW 1

                      Defines a relative power of 1 dB for the positioning reference signal.

CONFigure[:LTE]:DL:SFNO <Offset>

This command defines the frame number offset for the positioning reference signal.

Parameters:

<Offset>   <numeric value>

Example: CONF:DL:SFNO 4

                      Defines a frame number offset of 4.

9.8.3.4 Configuring the CSI Reference Signal

CONFigure[:LTE]:DL:CSIRs:CI <CSIRSConfiguration>

This command selects the configuration index for the CSI reference signal.

Parameters:

<CSIRSConfiguration>MNEM

Number of the configuration index.

Range: 0 to 31

Example: CONF:DL:CSIR:CI 12

Selects configuration index 12 for the CSI reference signal.

CONFigure[:LTE]:DL:CSIRs:NAP <Ports>

This command selects the number of antenna ports that transmit the CSI reference signal.

Parameters:

<Ports>   **TX1**

TX2

TX4

TX8

Example: CONF:DL:CSIR:NAP TX2

Selects 2 antenna ports for the CSI reference signal transmission.

CONFigure[:LTE]:DL:CSIRs:OPDSch <State>

This command turns overwriting of PDSCH resource elements for UEs that do not consider the CSI reference signal on and off.

Parameters:

<State>   **ON**

The CSI reference signal overwrite PDSCH resource elements.

OFF

PDSCH resource elements remain.

Example: CONF:DL:CSIR:OPDS ON

Overwrites PDSCH resource elements if necessary.

CONFigure[:LTE]:DL:CSIRs:POWer <Power>

This command defines the relative power of the CSI reference signal.

Parameters:

<Power>   Default unit: dB

Example: CONF:DL:CSIR:POW 1

Defines a relative power of 1 dB for the CSI reference signal.

CONFigure[:LTE]:DL:CSIRs:SCI <CSIRSSubframeConfig>

This command defines the subframe configuration for the CSI reference signal.

Parameters:

<CSIRSSubframeConfig>Number that selects the subframe configuration.

Range: 0 to 154

Example: `CONF:DL:CSIR:SCI 4`

Selects subframe configuration 4 for the CSI reference signal.

CONFigure[:LTE]:DL:CSIRs:STATe <State>

This command turns the CSI reference signal on and off.

Parameters:

<State>   ON | OFF

Example: `CONF:DL:CSIR:STAT ON`

Turns the CSI reference signal on.

9.8.3.5 Configuring the Control Channel

CONFigure[:LTE]:DL:PBCH:STAT <State>

This command turns the PBCH on and off.

Parameters:

<State>   ON | OFF

                   *RST: ON

Example: `CONF:DL:PBCH:STAT ON`

Activates the PBCH.

CONFigure[:LTE]:DL:PCFich:STAT <State>

This command turns the PCFICH on and off.

Parameters:

<State>   ON | OFF

                   *RST: ON

Example: CONF:DL:PCF:STAT ON
Activates the PCFICH.

CONFigure[:LTE]:DL:PHICh:DURation <Duration>

This command selects the PHICH duration.

Parameters:

<Duration>   **NORM**
Normal
EXT
Extended
*RST: NORM

Example: CONF:DL:PHIC:DUR NORM
Selects normal PHICH duration.

CONFigure[:LTE]:DL:PHICh:NGParameter <Ng>

This command selects the method that determines the number of PHICH groups in a subframe.

Parameters:

<Ng>   NG1_6 | NG1_2 | NG1 | NG2 | NGCUSTOM
Select NG_CUSTOM to customize N_g. You can then define the variable as you like with CONFigure[:LTE]:DL:PHICh:NOGRoups.
*RST: NG1_6

Example: CONF:DL:PHIC:NGP NG1_6
Sets N_g to 1/6. The number fo PHICH groups in the subframe depends on the number of resource blocks.
CONF:DL:PHIC:NGP NG_CUSTOM
Define a customized value for N_g.
CONF:DL:PHIC:NOGR 5
Directly sets the number of PHICH groups in the subframe to 5.

CONFigure[:LTE]:DL:PDCCh:FORMat <Format>

This command selects the PDCCH format.

Parameters:

<Format>   -1 | 0 | 1 | 2 | 3
*RST: -1

Example: CONF:DL:PDCCH:FORM 0
Sets the PDDCH format to 0.

CONFigure[:LTE]:DL:PHICh:MITM <State>

This command includes or excludes the use of the PHICH special setting for enhanced test models.

Parameters:

<State>   ON | OFF

                        *RST: OFF

Example: CONF:DL:PHIC:MITM ON
                        Activates PHICH TDD m_i=1 (E-TM)

CONFigure[:LTE]:DL:PHICh:NOGRoups <NofGroups>

This command sets the number of PHICH groups.

Parameters:

<NofGroups>   <numeric value>

                        *RST: 0

Example: CONF:DL:PHIC:NOGR 5
                        Sets number of PHICH groups to 5.

CONFigure[:LTE]:DL:PDCCh:NOPD <NofPDCCH>

This command sets the number of PDCCHs.

Parameters:

<NofPDCCH>   <numeric value>

                        *RST: 0

Example: CONF:DL:PDCCH:NOPD 3
                        Sets the number of DPCCHs to 3.

CONFigure[:LTE]:DL:PBCH:POWer <Power>

This command defines the relative power of the PBCH.

Parameters:

<Power>   <numeric value>

                        *RST: 0 dB
                        Default unit: DB

Example: CONF:DL:PBCH:POW -1.1
                        Sets the relative power to -1.1 dB.

CONFigure[:LTE]:DL:PCFich:POWer <Power>

This command defines the relative power of the PCFICH.

Parameters:

<Power>   <numeric value>

                            *RST: 0 dB
                            Default unit: DB

Example: CONF:DL:PCF:POW 0
                            Sets the relative power to 0 dB.

CONFigure[:LTE]:DL:PHICh:POWer <Power>

This command defines the relative power of the PHICH.

Parameters:

<Power>   <numeric value>

                            *RST: -3.01 dB
                            Default unit: DB

Example: CONF:DL:PHIC:POW -1.3
                            Sets the relative power to -1.3 dB.

CONFigure[:LTE]:DL:PDCCh:POWer <Power>

This command defines the relative power of the PDCCH.

Parameters:

<Power>   <numeric value>

                            *RST: 0 dB
                            Default unit: DB

Example: CONF:DL:PDCCH:POW -1.2
                            Sets the relative power to -1.2 dB.

9.8.3.6 Defining the PDSCH Resource Block Symbol Offset

CONFigure[:LTE]:DL:PSOFfset <Offset>

This command defines the symbol offset for PDSCH allocations relative to the start of the subframe.

The offset applies to all subframes.

Parameters:

<Offset>   **AUTO**
                            Automatically determines the symbol offset.

                            <numeric value>
                            Manual selection of the symbol offset.

                            Range: 0 to 4
                            *RST: AUTO

Example: CONF:DL:PSOF 2
Sets an offset of 2 symbols.

9.8.3.7   Configuring Shared Channels

CONFigure[:LTE]:DL:PDSCh:PB <PDSChPB>

This command selects the PDSCH power ratio.

Note that the power ratio depends on the number of antennas in the system.

Parameters:
<PDSChPB>   Numeric value that defines PDSCH P_B which defines the power
ratio in dB.

0

1

2

3

See PDSCH Power Ratio for an overview of resulting power ratios.

RAT1
Ratio = 1, regardless of the number of antennas.

Example: CONF:DL:PDSC:PB 3
Selects the PDSCH P_B '3'.

9.9 Configuring the Software

CONFigure:PRESet

Initiates a preset to the default state of the software, and, if connected to an analyzer,
also presets the analyzer.

Example: CONF:PRES
Presets the software.

Usage: Event

DISPlay[:WINDow<n>]:SELect

This command selects the measurement window.

Example: DISP:WIND2:SEL
Selects screen B.

Usage: Event

9.10   Managing Files

FORMat[:DATA] [<Format>]

This command specifies the data format for the data transmission between the LTE measurement application and the remote client. Supported formats are ASCII or REAL32.

Parameters:

<Format>   ASCii | REAL

                        *RST: ASCii

Example: FORM REAL

                        The software will send binary data in Real32 data format.

MMEMory:LOAD:DEModsetting <Path>

This command restores previously saved demodulation settings.

The file must be of type "*.allocation" and depends on the link direction that was currently selected when the file was saved. You can load only files with correct link directions.

Setting parameters:

<Path>   String containing the path and name of the file.

Example: MMEM:LOAD:DEM 'D:\USER\Settingsfile.allocation'

Usage: Setting only

MMEMory:LOAD:IQ:STATe <Path>

This command restores I/Q data from a file.

Setting parameters:

<Path>   String containing the path and name of the source file.

Example: MMEM:LOAD:IQ:STAT 'C:

                        \R_S\Instr\user\data.iq.tar'

                        Loads I/Q data from the specified file.

Usage: Setting only

MMEMory:LOAD:TMOD:DL <TestModel>

This command loads an EUTRA test model (E-TM).

The test models are in accordance with 3GPP TS 36.141.

Setting parameters:

<TestModel> **'E-TM1_1__10MHz'**
EUTRA Test Model 1.1 (E-TM1.1)

'E-TM1_2__10MHz'
EUTRA Test Model 1.2 (E-TM1.2)

'E-TM2__10MHz'
EUTRA Test Model 2 (E-TM2)

'E-TM3_1__10MHz'
EUTRA Test Model 3.1 (E-TM3.1)

'E-TM3_2__10MHz'
EUTRA Test Model 3.2 (E-TM3.2)

'E-TM3_3__10MHz'
EUTRA Test Model 3.3 (E-TM3.3)

Example: MMEM:LOAD:TMOD:DL 'E-TM2__10MHz'
Selects test model 2 for a 10 MHz bandwidth.

Usage: Setting only

MMEMory:STORe:DEModsetting <Path>

Stores the current demodulation settings to a file. The resulting file type is "*.allocation".
Existing files will be overwritten.

Setting parameters:

<Path>

Example: MMEM:STOR:DEM 'D:\USER\Settingsfile.allocation'

Usage: Setting only

MMEMory:STORe:IQ:STATe <Path>

This command saves I/Q data to a file.

Setting parameters:

<Path> String containing the path and name of the target file.

Example: MMEM:STOR:IQ:STAT 'C:
\R_S\Instr\user\data.iq.tar'
Saves I/Q data to the specified file.

Usage: Setting only

List of Commands

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